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TECHNICAL AND TECHNOLOGICAL EDUCATION IN BRITAIN

IN a brief reference to the importance of encouraging technological education in his Messel Memorial Lecture to the Society of Chemical Industry last July, Sir Henry Tizard manifestly carried his audience with him when he expressed the wish for less talk about the necessity of restoring the balance of science and technology, and more action. It was then a month since Lord Woolton had made his statement in the House of Lords debate on science and industry regarding the Government's intention of "building up at least one institution of university rank devoted predominantly to the teaching and study of the various forms of technology", and it was on June 17 and June 19 that the Minister of Education had promised, in answers to questions in the House of Commons, that the Government's proposals for increased assistance for selected technical colleges and courses would be announced "in a few weeks".

A further three months have now passed, and in the meantime the latest returns from the University Grants Committee have disclosed no indication that under present conditions the proportion of students of technology in British universities and university colleges is increasing: an increase of 0·5 per cent in full-time advanced students of technology scarcely offsets a decrease of three per cent in the total number of full-time students of technology. Lord Woolton, on a previous occasion, had commented on Sir Henry Tizard's summons to a spirit of adventure in urging the fuller use of existing knowledge by British industry; and in referring to the widespread demand for a separate university of technology, he stressed the importance of technology in opening, at the Science Museum, the exhibition to mark the centenary of the birth of Sir William Ramsay. He said that much of the work of British scientific men has not been applied in Britain itself because of our failure to train and absorb into our industrial life the practical scientists we have come to call technologists. If, in the face of world competition through the application of the scientific discoveries of our time, we are to reap the national benefit that fundamental science offers us, it will be necessary to create in Britain technological universities with the status and the distinction that is given to our existing universities; and through them to train a race of people who will see that the successors of men such as Ramsay meet with the encouragement and the rewards that are proper for the services they render to the community.

It is known that Lord Woolton has been inquiring into the practical possibilities of giving effect to the Government's proposal. The choice in practice would seem to lie between building an entirely new university or expanding one or more existing institutions and giving them university status. The former course would involve a delay of five years or more before the new institution came into being, and another three or four years before it contributed to the supply of graduates. For the second course a choice would presumably be made between some of the existing major colleges of technology.

The Manchester College of Technology has submitted a strong case for making it one of the cardinal centres for supplying industry with the larger numbers of first-class technologists that are required. A statement from the governors, and approved by the Manchester Education Committee, shows that the College is already equipping itself to expand its work in higher technological education by strengthening what is already essentially the applied science department of the University of Manchester. The teaching staff is being reinforced by ten new chairs, and while extensions to the College will allow of more departments and more students, effect is also being given to long-cherished plans for decentralizing to new branch colleges much of the work below university-level.

The speed at which these plans can be executed obviously depends upon the readiness of the Ministry of Education to approve the capital expenditure involved, and the statement is worth noting as illustrating the way in which the expansion of technological education is interlocked with that of technical education, and the importance of framing policy so as to ensure that the expansion of both proceeds in step. No estimate appears to have been attempted of the desirable rate of increase in the number of technicians required by industry, although a recent paper on postgraduate activities in electrical engineering related this to the expansion of industry, and suggested that industry would require to increase its recruitment of staff from the universities and colleges by five to ten per cent per annum.

The inquiry into the relation between vocational and non-vocational studies in the education of technologists, which the National Institute of Adult Education is proposing to undertake, in co-operation with the Association of Technical Institutions and the Association of Principals of Technical Institutions, could well have some regard to the quantitative aspect also. Dr. P. F. R. Venables has pointed out that, while the inquiry particularly concerns the major technical colleges, any such investigation must extend far beyond these institutions. It has already been agreed to give the commission the most general terms of reference; and if, in fact, its inquiries extend to the training colleges of industry itself, and the residential colleges maintained by local authorities, as well as to the extra-mural departments of the universities and the educational activities of the research associations and professional institutions, it should have at its disposal much of the information required for a quantitative picture.

The statement regarding the Manchester College of Technology is also worth noting, because it indicates that, whatever choice may be made as to the college selected as nucleus for the new institution, assuming the idea of an entirely new university is rejected, the expansion of these major colleges of technology and of the existing university departments of technology is also essential. They have a vital contribution to make, not only while the new institution is being built up but also as a permanent element in higher technological education. The figures recently published by the University Grants Committee show clearly that so far as numbers of students are concerned, the expansion of existing university departments of technology could probably be pushed as far as Sir John Cockcroft has suggested without distorting the balance of studies. Whether, from the point of view of avoiding wasteful duplication of expensive equipment or those other considerations which Prof. A. R. Ubbelohde has stressed, it would be desirable to go quite so far is another question.

It does not appear, however, why there need be much delay in making the necessary preliminary decisions, such as the location of the new institution and the approximate scale on which it is to be planned. Without prejudice to the merits of the case for the Manchester College of Technology—and the arguments for making it the nucleus of the new university of technology are by no means as convincing as those for the expansion at present projected by the governors, largely because of doubts as to the existence of sufficient room for expansion on the university scale—Manchester had every reason to expect some further statement from the Government when Lord Cherwell and Miss Horsbrugh received the honorary associateship of the College at the commencement of its jubilee celebrations on October 11. Lord Cherwell, in Lord Woolton's absence through illness, said nothing further about the Government's plans for higher technological education, either in relation to the Manchester College of Technology or regarding the new institution. Miss Horsbrugh quite properly disclaimed any responsibilities for higher technological education, but maintained her silence as to the plans for technical education, which is still a responsibility of her Ministry. Whether or not the occasion was appropriate for a general statement on technical education, the delay has now far outrun any reasonable interpretation of the "few weeks" claimed by the Minister in June.

That delay must in itself affect the execution of the plans for the expansion of the Manchester College of Technology. These plans, as already noted, contemplate the decentralization to subordinate centres of some of the more elementary work. Colleges of technology cannot give full scope to the more advanced work, and particularly postgraduate studies and technological research, the importance of which has rightly been stressed so strongly in the current debate on technological education, if they are at the same time to house elementary technical studies. It may not, indeed, be a wise step, either at Manchester or elsewhere, to divorce the colleges of technology entirely from work of a non-university standard, although if provision is made for part-time students from industry, the drawbacks of making such colleges exclusively university bodies should be minimized.

To establish satisfactory relations between higher technological education and the industrial world is a vital matter; much must depend on the co-operation of industry. One of the assets of existing institutions like the Royal Technical College, Glasgow, the Imperial College of Science and Technology, London, and the Manchester College of Technology is that they have already established links which should be pre-

served and are indeed capable of extension. There is, however, a quantitative aspect also, and it is this that shows up the weakness of the present arrangements for technological and technical education in Great Britain.

The colleges of technology cannot divest themselves of their present responsibilities for technical education, until alternative arrangements have been made for the education elsewhere of the technicians and craftsmen required in even greater numbers than technologists, and whose supply must expand in proportion as that of the technologists increases. These arrangements remain, however, the responsibility of the Minister of Education; and although that Minister will cease to be responsible for such of the colleges of technology as are given the academic freedom generally agreed as essential in higher technological education, it has not yet been made clear where the responsibility for the latter is to rest.

Meanwhile, the unsatisfactory nature of the present position and the desirability of placing the responsibility for the general supervision of higher technological education unambiguously on the same body that is responsible for watching over the universities is emphasized by such piecemeal action as that at Loughborough College. While the Minister of Education dallies in announcing a general policy, she has relieved the Leicester Education Authority of responsibility for maintaining the engineering and science departments of Loughborough. These departments will now be organized as a separate establishment, to be known as the Institute of Technology, Loughborough College, maintained principally by a grant from the Exchequer. The Minister has set up a governing body which became responsible for the Institute as from September 1; but it is not clear whether the new institute will have the academic freedom of a university institution or whether it is primarily a technical rather than a technological institute. What is manifest is that the development should have followed, rather than preceded, the Minister's statement as to general policy. The development will not diminish the widespread concern that both in technological and in technical education Government aid will be spread too thinly over too many institutions. When resources are limited, it is imperative that they should be distributed in accordance with a clearly and carefully thought-out policy, and not in response to particular representations.

It is impossible, therefore, to regard Miss Horsbrugh's remarks on October 11 with any satisfaction. A clear statement of policy is long overdue, and vague assurances of doing her best to meet the needs of both university and non-university work at Manchester and to help the Manchester Education Authority with its plans to build new local colleges are not enough. Some clear thinking is also required as to how and where to meet the needs of the part-time students to which Mr. David Cardwell, acting principal of the Manchester College of Technology, referred. Particularly at the present time, such students offer a promising means of securing that substantial increase in the number of graduates in technology which is so urgently required. Whether this could contribute towards an increase in post-graduate students and research workers in technology may require examination. Much would depend on the co-operation of industry; but so far as the remedying of Britain's weakness in the pursuit of technological research in academic institutions is concerned, Mr. Cardwell possibly put his finger on the real weakness in referring to the need for research grants. These clearly should not be expected to come from the local authorities, and if they are to come from the Exchequer, there is the more reason for giving the technological institutions concerned the independence and academic freedom necessary for the prosecution of research under the guidance of staff of the right calibre.

No one would suggest that, once the Government has made clear its plans for the expansion of both technological and technical education, the execution of those plans can be anything but a slow process. The concentration of technological education in a relatively few institutions, and the divesting by these institutions of their responsibilities for technical education, are bound to be gradual and may be protracted. The upgrading of the selected technical colleges in itself requires time. As an article "Education for a Scientific Age" in *The Round Table* recently observed, in this connexion, status and prestige cannot really be given: they must be won. It is likely to take some time before the degrees and diplomas granted by the upgraded colleges will be recognized as of the same value as those of a university.

Progress clearly depends largely on the calibre of the staff that the technical colleges are able to attract; they must be able to offer the conditions of academic freedom and salary that characterize a university institution, and this is one reason why early decision is imperative. Until policy is announced, the formulation of plans cannot proceed, and waste and frustration are likely to persist, to the detriment of that large measure of agreement which has already been reached as to the lines on which technological education should develop. Even the expansion of the university departments on the lines suggested by Sir John Cockcroft is likely to be hindered until the University Grants Committee has received such guidance from the Government.

Indecision in this matter, moreover, is a great handicap to the task of educating public opinion, which was so strongly urged in the last report from the Advisory Committee on Scientific Policy. Decision on the part of the Government is the first essential; given that, there is no reason for anticipating further delay on the part of the institutions concerned in giving effect to the policy formulated. It is to be hoped that in both Houses of Parliament early opportunity will be taken to press the Government on the matter, and that the pressure will be maintained until a decision is announced. On the Government's own showing, the whole question is too important to the future of Britain to be allowed to remain indefinitely in the position when a change of Government could once again throw the whole matter into the melting-pot.

PROGRESS IN COSMOLOGY

Cosmology

By H. Bondi. (Cambridge Monographs on Physics.) Pp. ix+179. (Cambridge: At the University Press, 1952.) 22*s*. 6*d*. net.

IN his presidential address to Section A (Mathematics and Physics) of the British Association in 1888, G. F. FitzGerald suggested that "a successor in this chair might well devote himself to a review of the cosmical theories propounded within the last few years". He added, "The opportunities for piquant criticism would be splendid". Since there seems never to be lacking a supply of these theories produced "within the last few years", there is naturally not lacking a number of men of science still sharing FitzGerald's attitude towards them.

Criticism there must, of course, be. But the important thing is that general progress is being made in the study of the large-scale problems of the physical universe. Observational evidence is accumulating; this in itself is almost inevitable, but there is also progress in appreciating its relevance and significance from a general physical point of view apart from highly specific theories. On the side of the theories themselves, much has been learned that could be discovered only by the actual working out of the results of their attempted application to the cosmological problem; each serious new theory seeks to overcome the difficulties encountered by its predecessors. In the course of the work, much has been learned, too, about various general physical theories as such, apart from this particular application. Some theorists would claim that fundamental insight has been gained into the origin of laws of Nature. Above all, the main problems to be solved in cosmology are becoming more and more clearly formulated; and, though the theories differ greatly in their ways of getting results, when due regard is paid to the features common to the results themselves, definite progress towards the solution of some of these problems can undoubtedly be claimed.

As a masterly account of this whole state of affairs, it is hard to imagine anything that could be better than Mr. H. Bondi's book. By the exercise of the greatest skill in marshalling his material and of the utmost clarity of expression, he succeeds in making his account effectively complete without any sense of undue compression. Also, he does not shirk the exposition of what is essential in the technicality of the work, while always giving primary attention to the concepts involved.

Though scrupulously fair to other theories, Mr. Bondi naturally states his preference for the "steady-state" theory of cosmology, with its concomitant hypothesis of the continual creation of matter. This theory was originated by him and T. Gold in 1948. They did not claim that it *must* be correct, but Mr. Bondi points out the extreme epistemological difficulty in the way of any fundamental progress if it is found to be false. Actually, it does seem to give a better account of the large-scale behaviour of the universe than does any previous theory. However, it encounters the obvious trouble that the universe does not conform strictly to the "perfect cosmological principle", from which the theory is derived, though there is no evidence that it does not conform statistically. F. Hoyle's alternative approach, originally published about the same time, is more satisfactory from this point of view, but Hoyle was not so concerned to deal with the epistemological situation. All this is clearly explained in the book.

It seems to me that the relationship between the procedures of Bondi and Gold and of Hoyle indicates the way in which further progress may be expected. They illustrate the "deductive" and "extrapolating" procedures so well distinguished by Mr. Bondi (p. 5). Whereas in the past this distinction has been ill-recognized and has resulted in fruitless controversy, we now have an instance of the procedures tending to consistency. A fundamental examination of the conditions for consistency of the two types of procedure is required and may yield the next advance.

W. H. McCrea

AMPHIBIANS OF WESTERN NORTH AMERICA

Amphibians of Western North America

By Robert C. Stebbins. Pp. xvii+539 (64 plates). (Berkeley and Los Angeles: University of California Press; London: Cambridge University Press, 1951.) 56*s*. 6*d*. net.

IT is refreshing to find an author who makes no pretensions to writing for the benefit of some section of his fellow men, but says with simplicity, "I have put into the volume what I have wanted to know . . .". The result reveals Mr. R. C. Stebbins as a naturalist, and for anyone who, like him, wants to know not only what amphibians occur in western North America but also, and above all, how and under what conditions they live, the book provides a great many answers; it also provides a wealth of comparative information for others of similar bent but concerned more directly with other geographical regions.

As a member of the staff of the Museum of Vertebrate Zoology of the University of California, the author is an experienced taxonomist, and the framework of the book is the taxonomic arrangement of the animals. There are keys, accompanied by explanatory diagrams, for the identification of the animals both as adults and larvæ. Species and subspecies are described and figured, and their general and local distribution indicated and mapped. Then, for each form, there are extensive notes on its behaviour, habitat, food, reproduction and so forth. These notes are based on the author's personal observations or are taken from impeccable sources, many of them hitherto unpublished. Twelve plates show typical habitats, and there is a glossary of technical terms as well as an index.

No book of this kind can satisfy everybody. Those whose interests are mainly ecological will doubtless regret the absence of physical data relating to the different types of habitat, information regarding predators, parasites and so on. Others, more taxonomically inclined, will wish that more had been said about the very interesting phenomenon shown by the salamander *Ensatina eschscholtzi*, where the end-terms of two subspecies chains, deriving from a common stem, meet and behave as distinct species; that more, too, had been said about the discontinuous distribution of *Ambystoma tigrinum* and its causes; and that genera and subgenera had been less capriciously treated. But apart from such matters of scope and emphasis, there are few serious defects for criticism. The segregation of the illustrations of the larvæ and of the distributional maps away from the

main accounts of the species has the advantage of facilitating direct comparisons but little else to recommend it. Some may also find it a nuisance that habitats are sometimes described in terms of life-zone concepts (for example, Sonoran, Hudsonian, Arctic Alpine) that are not defined in the book, rather than in terms of the natural vegetation the distribution of which is mapped (Plate 47).

There can be no doubt of the quality of this book with its reliable information and excellent illustrations, and equally there can be no doubt that its publication will stimulate studies that must result in an increased knowledge of a group of animals still relatively little known. H. W. PARKER

SCIENTIFIC PRINCIPLES OF FURNACE TECHNOLOGY

The Science of Flames and Furnaces

By M. W. Thring. Pp. xiv+416. (London : Chapman and Hall, Ltd., 1952.) 42*s*. net.

THIS book is a useful contribution to the scientific study of flames and furnaces, a subject in which a fairly extensive background of applied science already exists, but is not readily accessible to the average reader of the subject. Furnace design is a somewhat specialized subject, and furnace practice is almost every industrialist's concern. Nevertheless, the systematic treatment of the subject in text-books has been curiously enough neglected. It would be unfair, however, to claim that furnace technology is therefore backward, though frequently such criticism of modern furnace development has been heard. In point of fact it is commonly the rule in the technology concerned with the development of valuable industrial plant that practice is in front of the text-book exposition of the subject. In the present case, however, as the title of the volume indicates, the author is concerned with the science rather than with the technology of the subject.

The introductory chapters are devoted to the heat liberation from the flame and the subject of heat transmission. Novel features deal with the interpretation of the second law of thermodynamics in terms of what has been called the 'virtue' of a system's energy, and a more than usually complete treatment of the subject of flame radiation. One doubts whether the introduction is necessary of such special terms to define the obvious value of the heat potential of the fluid above the levels of temperature in the furnace. Indeed, such may even lead to confusion of ideas. Useful summaries of recent experimental work in furnace investigations, in heat transmission and in the determination of thermal constants are given. These constitute perhaps the most valuable features of the work. Again, under the somewhat pedantic title of "Aerodynamics of Hot Systems" are included those sections of the work which describe the science of draughting of furnaces and of jets of hot gas. This chapter comprises a good collection of references, but resembles so much a series of notes and mathematical formulæ, signs of a worthy effort to collect as much information as practicable into a limited number of pages, that the reader is left with the feeling that for an effective understanding of the subject he must still consult the original papers. The chapter purporting to cover the science of furnace construction is mainly devoted to refractory and insulating materials. It is so condensed that it serves only to give guidance to a very limited series of references.

The final chapter on scientific method is a valuable and suggestive one.

The paragraphs are numbered in the manner of the Cambridge mathematical texts. It is doubtful if the average reader takes much notice of the numbering, but he will profit from the useful summaries at the ends of the chapters. This may in some degree compensate for a somewhat meagre index. The book is well produced, the printing clear, and the illustrations legible.

ORNITHOLOGY OF THE CHANNEL ISLES

The Birds of the Channel Islands

By Roderick Dobson. Pp. xvi+263+25 plates. (London and New York : Staples Press, Ltd., 1952.) 30*s*. net.

IN the middle of the last century a great change began to take place in the use of the land in the Channel Islands, owing to the development of early fruit and vegetable growing for the London market. This necessitated the cutting down of orchards to make room for glass-houses, the draining of wet ground, and clearing of rough areas for early potatoes. Unfortunately there is little information as to the status of the resident species, or summer visitors, previous to 1866 when Cecil Smith published his "List of Birds . . . Summer Visit to the Channel Islands, exclusive of Jersey", which was amplified in his "Birds of Guernsey" (1879). Some species have ceased to breed owing to the increased utilization of the land, and others from some unknown cause. The choughs, for example, were common in Guernsey in 1878, in Alderney they ceased to breed in 1876, in Jersey in 1880, and in 1929 a pair were seen in Guernsey—the last record for the Channel Islands. In the British Isles the increase of jackdaws is sometimes blamed for the decrease of the chough ; but in the Channel Islands jackdaws were never very abundant and have now decreased, and only a few nest in the western half of Jersey.

It is interesting to note that during the German occupation carrion crows, which in the breeding season were formerly confined to the cliffs, began to nest in woods and trees inland. This was owing to all the farmers' guns having been confiscated. During the same period the Germans felled many of the tall trees in the sheltered valleys, with the result that in a year or two the undergrowth increased and blackcaps and garden-warblers began to nest again, which they had not done for many years. On the cliffs and rocky islands around Guernsey and the other main islands, many kinds of sea-birds breed and, during the Second World War, an additional species—the gannet—established colonies on the rock of Ortac and Les Etacs, off Alderney.

The information about each species is arranged in this book under the four largest islands, and in some cases the available information is rather meagre ; nevertheless this is a valuable contribution to the ornis of the Channel Islands, and no doubt in a future edition there will be many additions to the list of species, especially among the migrants. There are a number of photographs of various birds, nests and well-known breeding places.

UNIVERSITY BOTANICAL TEACHING AND TRAINING

IN *Nature* of April 28, 1951, the leading article raised the importance of university departments of biology (both botany and zoology) for the training of biologists to satisfy the needs of the modern State. We then pointed out that among those working in the wide and varied field of applied biology there was a general conviction that Great Britain and the Commonwealth was suffering from a dearth of plant and animal physiologists. This article inspired Sir William Slater to write shortly afterwards (*Nature* of June 2, 1951) to point out that the Agricultural Research Council was seriously concerned about the shortage of animal and plant physiologists with an adequate knowledge of chemistry and physics and of biochemists with biological experience, and to emphasize the important efforts which the Council was making in this direction.

This adds point, therefore, to the discussion organized by Section K (Botany) of the British Association on September 5 at Belfast. The discussion is fully reported in the following columns by Prof. L. J. Audus. The three main contributors to the discussion—Dr. Eric Ashby, Dr. W. B. Turrill and Mr. Peter Bell—raised issues of the utmost importance. We felt, however, that this was a very important discussion, and that it, like most discussions in connexion with which no special invitations to speak had been accorded to anyone other than the readers of the main papers, might prove to be an unbalanced review of authoritative opinion throughout the country, in spite of the fact that a number of botanists contributed useful points after the papers had been read.

So it was decided to approach a number of other botanists who either were not present at the discussion, or, if they were, did not speak, to contribute their views now. Copies of Prof. Audus's report were sent to them and their comments follow the main report here. In most cases, no department of botany was approached if one of its members had spoken at the Belfast meeting. It should be pointed out, however, that Prof. Audus himself was invited to submit a written comment, since, with the aim of making his written report as objective as possible, he did not speak at the discussion itself. A few authorities, for specific reasons, preferred not to contribute to this discussion.

Although in most cases the head of the department was originally approached, and in some cases it seems that he consulted his assistants, it should not be taken for granted that any one contribution is the considered opinion of the entire department concerned.

It will be noted, as one might expect, that the opinions expressed indicate that the problem is heterogeneous; for example, the small department has problems which the large department does not have to face. Moreover, individual authorities raise special points. But apart from this, there are several general themes which have been brought out, and these might with advantage be given careful consideration by all university and college departments of botany.

The British Association Discussion

THE rapid expansion of botany as a university subject in recent years and its growing importance in a world faced with grave food shortages has recently caused university staffs to reconsider whether present degree courses are suited to modern needs. A whole morning's session in Section K (Botany) of the British Association was devoted to "The University Training of a Botanist" at the Belfast meeting on September 5.

DR. ERIC ASHBY (QUEEN'S UNIVERSITY, BELFAST), who opened the discussion, explained that the purpose of his paper was to examine the botanical curriculum, its determining factors and the case for its reform. To keep the discussion within bounds it was necessary to limit its scope to honours courses in botany considered solely as a training for professional botanists (not including school teachers).

The curriculum should be influenced by: (1) the corpus of botanical knowledge and fields of current research; (2) the requirements of employers; (3) the aptitudes of students. Other 'illegitimate' influences, for example, the bias of university staff and inertia of examiners, would be disregarded.

(1) The corpus of botanical knowledge has changed enormously since 1900. From 1900 until 1910 it was sufficient only to know botany in order to understand any botanical research paper. From 1940 until 1950 many papers could not be understood without some knowledge of chemistry, mathematics and physics. The change was illustrated by a study of examination papers over the past fifty years. Thus the examinee of 1950 was expected to answer some 95 per cent of questions set forty to fifty years ago, whereas an examinee of 1900–10 could not have attempted some 40 per cent of the 1950 questions. By and large, honours botany curricula still contain as much comparative morphology, etc., as they did in 1910, while genetics, much more physiology, ecology and cytology have all been squeezed in without any lengthening of the course.

At the research-level the classical problems are still relevant and no nearer solution than they were fifty years ago, and we would do a serious disservice to our subject if we discarded those problems or no longer taught the raw materials necessary for thinking about them. Meanwhile most botany research workers prefer fields where solutions are easier to obtain, as is shown by the type of research taken up by British postgraduate botany students in 1951 (University Grants Committee data), that is, taxonomy 8; genetics 30; ecology 16; physiology 22; pathology 16; mycology 14. Thus the content of botany has enormously enlarged, yet the material included fifty years ago cannot be entirely discarded. This is the dilemma of the botanical curriculum.

(2) Universities are primarily institutions for training professional men and women. In 1900 most botanists were employed by universities, herbaria and botanical gardens. To-day there is a much wider range of employers. Apart from the teaching profession, the biggest employer of botanists is the Government (Agricultural Research Council and

Department of Scientific and Industrial Research), then the Colonial Service and then the universities. Demands are for physiologists, biochemists, pathologists, plant breeders and experimental ecologists. In 1950 the Ministry of Labour and National Service published a pamphlet stating that over the period 1950–54 the supply of honours botanists was likely to be about twice the demand. Although these demands were probably underestimated, yet even with adjustments the figures are disturbing. Notwithstanding this threatened excess, bodies like the Agricultural Research Council and the Colonial Office cannot get recruits of the right calibre or training for their vacancies [see also *Nature*, 167, 659 and 908; 1951]. The majority of honours botanists that apply can discuss at length the classical problems of morphology but cannot, for example, design the simplest field experiment in agricultural botany. They are therefore of no use to these principal employers.

(3) The aptitudes of botanical students have changed in the last fifty years. On the whole, in 1900, botanical students were naturalists. They had, therefore, good visual memories and enjoyed the techniques of evaluation as contrasted with measurement. But most modern botany students are fundamentally not naturalists. By temperament and aptitude they are experimentalists. For them field-work is difficult, and they must learn their plants anew each year. They are uninterested in the arguments of classical botanists. These two kinds of student are as different as chalk is from cheese yet we are forcing them both into the same mould. The born taxonomist ploughs his way in misery through the tortuous paths of metabolism. The born physiologist suffers resignedly the unconvincing arguments of the morphologists. It is our duty to change the curriculum to meet the needs of both these types of botanist.

The conventional adjustment of the curriculum is usually to reduce the number of types, to skimp reading of classical papers, to cut practicals but never to leave even one group out. As a guide in making reforms, however, one should take as a model the techniques of the classics curriculum. There seem to be two principles involved. The first is to select a few authors and to study them exhaustively until one lives in the climate of their thought; the second is to ensure complete familiarity with comparatively few works of genius. The power of classical education depends on this second principle. This contrasts strongly with the principles underlying an honours course in botany. Here insistence on some contact with every aspect of the subject inevitably means that only the most superficial consideration can be given to any one subject and nothing can be studied exhaustively and really understood. On the experimental side this is particularly marked, and is positively harmful, for it misses the main point of experimental work, that it is not always successful and that the experimenter has to repeat and repeat until results are consistent. Furthermore, one can graduate well in botany without ever having opened a book by Darwin or read a paper by Sachs or F. F. Blackman, but not if one has omitted to struggle through a score of books by industrious but negligible writers just because they contain the most recent information.

Dr. Ashby next turned to some practical proposals. He first assumed that it is not possible on economic grounds to lengthen the honours botany course. This means that something must be omitted. The first omission should be compulsory zoology. Although it might be desirable for school teaching and certain very specialized jobs, the professional botanist has far more to learn from the chemist, the mathematician and the physicist. In the first post-intermediate year let all botanists do the same general course. The non-experimental botanist, who is easily distinguishable even at this stage, should take in addition geology and some zoology, while the experimental botanists should take instead chemistry and physics. In the second and third post-intermediate years they should be separated into two streams. The non-experimentalists would take anatomy, comparative morphology and evolution, taxonomy, floristic plant geography, genetics; together with geology, some zoology and some climatology. The experimental botanist would take anatomy, physiology, experimental ecology, genetics, plant pathology, mycology; together with chemistry, biochemistry, physics (properties of matter and some physical techniques), elementary mathematics and statistics. This would leave time for work to be done with a precision and thoroughness not devoted to it for forty years. It would, indeed, turn out botanists who had never 'done' the vascular cryptogams except in an elementary course and others who would not be able to read a modern paper on photosynthesis; but it would produce a taxonomist who has spent time on palæontology instead of wasting it on fat metabolism and a physiologist who knew enough physical chemistry to understand fully modern papers on salt absorption, etc.

DR. W. B. TURRILL (THE HERBARIUM, ROYAL BOTANIC GARDENS, KEW), who followed, confined his attention to the teaching of angiosperm systematics. He was tempted to suggest that taxonomy could not be taught. What can be done is to train the student to teach himself. However, the attempts that had been and still were being made to do so could be classified under six heads.

(1) The direct method of selected 'type' families, which is extremely dull.

(2) The historical method, which is wasteful of time as a basis for modern teaching.

(3) Philosophical method. This could be properly effected only with students already possessing considerable experience.

(4) Phylogenetic method. This is the easiest method to teach; but the dangers are that speculations would be taken for established fact.

(5) Practical. Here there are several different approaches; but in all it is essential that the student shall handle material himself and learn to work out characters, constancies and correlations from specimens and not from lecture notes. Advantages are that learning is easy, initiative is at a premium and the research habit is developed.

(6) Synthetic method. This is the method for the future whereby all the good points under the preceding five headings are combined and the bad ones are eliminated. How far is this synthesis possible?

There are clearly two types of botanist, taxonomist and non-taxonomist; but the latter should have a sufficiently wide knowledge of taxonomy to be able properly to appreciate its purpose, methods and problems. Taxonomy cannot be learnt by the 'type' method. Its very essence is the detection of correlations. Selection of material is essential; but too early specialization must be avoided. Early on, the need for a universally recognized system should be simply explained and theories concerning it briefly

outlined. Students should then be turned loose in the field with a flora to work out the plants of an area for themselves. Later there should be concentration on a few families limited to the local flora: not as 'types' but for the study of character evaluations, correlations, variation and reticulation. Then there should follow the study of a single genus in detail, perhaps extended to extra-British species.

Since the British flora is too limited to furnish a full appreciation of variation of structure and behaviour, serious study should eventually be made of at least one tropical family.

Detailed theories of classification should be deferred until the student has acquired sufficient facts to appreciate the linkage of practice and theory; but suggestive generalizations should be introduced gradually as factual knowledge grows, and to this end modern methods and detail should replace historical subjects. An experimental garden is essential, since in it students can learn much of fundamental importance, such as distinctions between phenotype and genotype, character plasticity, genetic isolation, etc. The study there of species problems will lead to integration of orthodox taxonomy not only with morphology but also with all that is latest in plant physiology.

The number of posts for professional taxonomists is limited. Only those students who have a definite flair for it should be encouraged to take it up as a career. Only a few universities are at present equipped to give the necessary specialized training. Other university departments of botany should aim at giving their students a sound general training, as already outlined, and leave specialized training to a postgraduate apprenticeship period at some centre of taxonomic research.

MR. PETER BELL (UNIVERSITY COLLEGE, LONDON) regretted the omission from Dr. Ashby's paper of aspects of training bearing on the teaching of botany in schools, since most present-day students came up lamentably equipped for a modern course in botany. The analysis of subjects chosen for research by recent graduates was of no significance in the discussion, since such choice was dictated primarily by the availability of money for specific subjects.

He could not agree with Dr. Ashby that the specific requirements of government departments for special types of botanist should be allowed to influence the content of an honours degree course. He did, however, agree with his two principles of teaching, that is, doing a few things well and becoming familiar with the workings of powerful intellects. This first principle was frequently adopted in morphological teaching. The difficulty of dealing with the second would be to decide who were the great minds in the botanical world.

Turning to Dr. Ashby's concrete suggestions for reform, he held that students could not be divided readily into "naturalists" and "experimentalists". There was a complete dovetailing of both these aspects over the whole field of botany. Up to graduation the botanist's training should therefore be general, and special accessory knowledge for experimental research, for example, statistical methods, physical chemistry, etc., should be picked up when the need arose in postgraduate years. A general view of the advances in the whole subject was essential for anyone attempting research in botany.

In the informal discussion which followed, most of the speakers agreed that Dr. Ashby's suggested reform required specialization at much too early a stage, before students could be reasonably expected to have decided precisely what aspect of botany they wished to follow.

DR. H. HAMSHAW THOMAS (CAMBRIDGE) said that botany courses could and should provide a real intellectual training for students, by no means all of whom were destined to become professional botanists. This should include the writing of clear and intelligent English and an appreciation of the meaning and implications of words. He hoped that Dr. Ashby's suggestion that we might profitably copy the excellent teaching methods of the classicists would be given careful attention.

PROF. JOHN WALTON (UNIVERSITY OF GLASGOW) said that the training of research workers in a special line should be left to the Ph.D. period, when they should take courses in those allied subjects that they specially required, for example, biochemistry, statistics, genetics, etc.

DR. JOHN RAMSBOTTOM (FORMERLY BRITISH MUSEUM (NATURAL HISTORY)) pointed out that botanical courses were designed originally for teaching botany as a discipline, almost entirely to intending teachers, and were correspondingly stereotyped. This tradition persisted. Before steps were taken, however, to make it difficult to study botany as a whole, an effort should be made to produce a more balanced and realistic syllabus.

DR. J. L. CROSBY (UNIVERSITY OF DURHAM) said that the history of botany should be an important part of any university course in order to understand how ideas have developed and to obtain full benefit from the botanical classics.

DR. J. HESLOP HARRISON (UNIVERSITY COLLEGE, LONDON) found it difficult to accept Dr. Ashby's proposition that botanical science could be divided into experimental and non-experimental. If those botanists who are to tackle the unsolved classical problems are to be segregated early from the physiologist stream, then this is the way to ensure that those problems are never solved. Little can now be expected from purely observational methods, and the past forty years have shown us that progress with these problems can best be achieved by application of experimental techniques by those trained in physiology. Specialization must therefore be deferred at least until the student has gained some appreciation of the science as a whole, which is usually not until he has graduated after a broad general honours course.

DR. P. F. WAREING (UNIVERSITY OF MANCHESTER) suggested that 'botanists' did not appreciate the real point at issue. The modern plant physiologist requires a knowledge of very advanced chemistry and this cannot be 'picked up' when needed after graduating. Dr. Ashby's scheme was to meet this difficulty, and so far no other practical alternative had been suggested.

The student point of view was put by MR. J. E. DALE (KING'S COLLEGE, LONDON), who said that the good student would plan his own course of study, irrespective of academic direction. He is the person who ultimately decides where and when specialization will start.

DR. W. MATHIAS (UNIVERSITY OF LIVERPOOL) was sympathetic with the view expressed by Dr. Hamshaw Thomas that a university training should be non-vocational, but how many present-day students are stimulated by considerations other than vocational?

Dr. Ashby replied to the points made during the discussion. He said that the chief objection raised against his suggestions was that they involved specialization at too early a stage in the botanical course. But the honours student is committed to early specialization in any event; and it was therefore necessary to weigh its drawbacks against the advantages of a thorough training. L. J. AUDUS

Further Contributions

PROF. L. J. AUDUS, BEDFORD COLLEGE, UNIVERSITY OF LONDON

The modern professional botanist, whatever his particular specializations, must possess a proper appreciation of modern concepts on form and function in the plant kingdom. For this he needs, in addition to his general botanical training, a thorough grounding in chemistry, physics and mathematics and a knowledge of certain aspects of these subjects as deep as that possessed by the relevant specialist. In addition, the experimental botanist entering Government or Colonial Service needs a knowledge of special techniques that can be neither quickly nor easily acquired. It is altogether too optimistic to suggest that all this can be squeezed into a three-year honours course, even with the modifications and omissions proposed by Dr. Ashby.

A fourth postgraduate year for specialized training is essential if we are to avoid turning out mere 'technicians' as a result of too early and too narrow a specialization. The courses in the three pre-graduate years need not differ in structure from those at present in operation except that physics and chemistry of an appropriate type and standard should be obligate subsidiary subjects. Specialization in botany should not be carried quite as far as it now is in some honours schools, but extra time should be devoted to particular associated techniques, for example, statistics, etc. In the postgraduate year the specialization could be as extreme as the particular types of training demand and could terminate in an M.Sc. by examination. The school teacher would, as now, follow the course up to the first-degree stage, and this would avoid the invidious distinctions, implicit in Dr. Ashby's suggestions, between professional botanists and school teachers, whose prestige has already fallen dangerously low. We must nurture our prospective teacher on the same interesting diet as we nurture our prospective research workers or we destroy at the source the interest and enthusiasm of our future professional botanists.

PROF. T. A. BENNET-CLARK, F.R.S., KING'S COLLEGE, UNIVERSITY OF LONDON

IT was evidently suggested by many speakers that Dr. Ashby's proposed reforms required specialization at too early a stage, and the astounding view was even expressed that "physical chemistry, etc., could be picked up" after graduation. Incidentally, why not pick up extra morphology after, rather than before, graduation?

All this reads like the most unwelcome proposition that pure botany is more desirable academically than a broadly based scientific training with appropriate chemical, physical and biological disciplines. To regard this pure botany as less specialized than Dr. Ashby's experimental course is incomprehensible.

The narrow specialization of the botany of fifty to sixty years ago represents a very arbitrary segregation of a single compartment of natural knowledge largely determined by the direction of research in the eighteenth and early nineteenth centuries. It is no longer a very convenient subdivision, if students are to be forced by syllabuses or regulations to remain confined within it, when current research advance is in the so-called borderline sciences. My support for reform on lines like those suggested by Dr. Ashby is based on the belief that such reform could permit less specialization than frequently occurs now and that it should also blur the very arbitrary sharp boundaries between the sciences. Different universities would no doubt attempt different patterns of reform to permit easy integration of the basic sciences.

PROF. G. E. BRIGGS, F.R.S., UNIVERSITY OF CAMBRIDGE

The system of training botanists which Dr. Ashby criticizes and that which would result if his amendments were adopted are different from that which has developed at Cambridge. As it has been intentionally adjusted from time to time as the subject has developed, it may be useful to others to describe its present state.

During his first two years a student must read at least two other sciences chosen from a wide range, including mathematics, the only restriction being that of the time-table. For example, he can combine chemistry, physics and mathematics with his botany or he may read zoology and geology. A common combination is botany and zoology with organic chemistry and biochemistry, the two latter together counting as one subject. In his third year, when he reads only botany, he is encouraged to attend lectures and practicals in all branches; but the examination allows for specialization.

The bias of the university staff is allowed to have an influence. No attempt is made to cover the whole field of botany, nor do we try to deal with all the sub-sections of a section such as plant physiology. By dealing with the parts of which he has special knowledge, the lecturer hopes to form habits in the student which will be generally useful to him at a later stage.

PROF. A. R. CLAPHAM, UNIVERSITY OF SHEFFIELD

Dr. Ashby is surely incorrect in saying that "by and large, the honours botany curricula contain as much comparative morphology, etc., as they did in 1910": there are several university departments in which only one or two selected groups are treated in the old detail, the time so saved being devoted to modern branches of botany, experimental or non-experimental. I agree with him that honours courses should not be lengthened; but I agree with Dr. Peter Bell and others that there should be no division of the undergraduate class into 'naturalists' and 'experimentalists'. Students cannot be clearly divided into such categories, and they should not be obliged to make the implied decision before they take their first degree. I have known many whose primary interests were taxonomic or ecological but who were either experimentalists by inclination or who at least recognized the desirability of a training in experimental attitudes and techniques. Such men ensure that no branch of botany remains non-experimental, and they contribute in a most valuable way to botanical progress.

It is, moreover, undesirable that there should be any lessening of the opportunities for contact between honours students of diverse interests, for this contact plays an important part in undergraduate training. The experience of many botanical departments is

that it is not difficult, by the careful designing of courses and examinations, to continue to give a wide botanical training and yet to foster special interests to an adequate extent. If these courses remain at their present length there is time for narrower specialization in postgraduate courses of training in research.

Prof. Ronald Good, University College, Hull

Many will agree with Dr. Ashby's diagnosis that the problem now facing teachers of botany in universities is due partly to the growth in content of that subject and partly to a tendency for it to become increasingly vocational, though how far the former reflects the latter may be more debatable. It is often suggested that some reduction of the burden by a process of sub-division or dichotomy has become inevitable, and it is therefore important to remember that there is more than one way in which this might be achieved. That most commonly mentioned is by division on the basis of subject-matter, which may be called the 'physiology or morphology' point of view, but there is also the possibility of making the division more clearly one between the academic and the technical.

The real trouble is that at present the fiction that the whole subject of botany can still be taught in a single manner for all purposes results in too frequent failure to do the thing which matters most, namely, to provide, in Dr. Hamshaw Thomas's phrase, "a real intellectual training for students". Might not the inevitable dichotomy be better made between students rather than between parts of their subject, so that the training of those with greater natural scientific aptitude might be different from, and perhaps more academic than, that given to those whose gifts lie more in the application of knowledge? If this is indeed the direction in which a solution of the problem is to be found, however, then one cannot but wonder how long a design of higher education which contains only one pattern of university institution and but a single system of degrees will continue to be entirely sufficient.

Prof. F. G. Gregory, F.R.S., Imperial College of Science and Technology, London

In recent years botany has developed rapidly as an applied science: in (*a*) pathology, (*b*) plant breeding, (*c*) agronomy or crop physiology. Meanwhile botany remains as before a pure science embracing anatomy, morphology, systematy and physiology. The curriculum should be adjusted to both these needs. It will inevitably be influenced by the interests and capabilities of the teaching staff.

Dr. Ashby's suggestions for the reform of the curriculum seem acceptable and indeed are urgent. There are two types of botanical students, and after the preliminary post-intermediate first year both types should be catered for by a bifurcation in the direction Ashby has indicated.

Perhaps one should go even further in the interests of applied botany, and after the second post-intermediate year separate those who incline towards mycology and plant pathology from those whose interests are physiology and microbiology. In the third post-intermediate year the physiologists should spend a considerable part of their time in the study of advanced organic chemistry, enzymology, biochemistry and physical chemistry.

It may be necessary eventually to separate off physiology completely as an independent discipline. Such a reform would entail a much closer liaison between the teaching departments in the physical and biological sciences and would necessitate an increase in the staffs of the physics, chemistry and biological departments.

Prof. F. M. Haines, Queen Mary College, London

It is agreed that the curriculum for different types of student should be even markedly different and that the different types of student can be recognized by their preferences and aptitudes at an early stage. At the same time, the first essential is to provide opportunity for studying the subject so far as possible as a coherent whole. In doing so, moreover, some preferences change and further aptitudes develop. The now patent dependence of, for examples, taxonomy on cytogenetics, of cytogenetics on biochemistry, of anatomical structure, life-histories and ecology on physiological principles and so forth, emphasizes the artificiality of segregating different aspects of the subject or divorcing any from the rest.

The principles of the different disciplines should be taught side by side for as long as the corpus of knowledge allows and segregated only to the minimum dictated by teaching convenience. The University of London regulations already allow a choice of ancillary subjects to be followed prior to the attainment of the standard of the General Degree, these being optional and suited to the student's aptitude and outlook; they also allow a considerable degree of specialization in the final pre-graduate year, in which the born taxonomist need not be tortured by any further physiology, or physiologist by further morphology. Further specialization, or at an earlier stage, is not necessary at all events yet, and though deplorable enough on the grounds indicated above, would be even more so to those who still look to a university course for educational or cultural as well as vocational development.

Prof. T. M. Harris, F.R.S., University of Reading

Dr. Ashby deals mainly with the honours course with supporting subsidiary subjects; but my direct experience has been with the systems of Cambridge and Reading, where a student reads three equal subjects, takes a degree examination and then possibly a final year on botany alone. However, his remarks apply here also, and I am sure the course is apt to be overloaded.

It is difficult to lighten the B.Sc. General all round without skimping practical work and reading; it seems that some neglect is better. I think this can be left to the student by giving him more choice in examination so that he can safely drop certain fractions of the course. This spares him revision and reading; but I would make him do nearly all the class work so that he knows what he is doing.

The B.Sc. Special course at Reading is a graduate course for a very few selected students, and as they are allowed to do pretty well what they want, its faults are outside the scope of Dr. Ashby's remarks.

Finally, may I plead for more liberty of choice for the student? I believe that in the years I have seen, planning has narrowed the field of liberty even in university education, and almost entirely to the detriment of the best students.

Prof. C. T. Ingold, Birkbeck College, University of London

Universities are not concerned with turning out graduates in botany tailor-made for applied research. Those employing botanists should be prepared to

select graduates of the right calibre. Their training in the advanced techniques necessary for the particular job should come later.

Some measure of specialization for the student in his final year (not earlier) is desirable and necessary because of the huge body of botanical knowledge. In most universities this is already normal practice. Further, all students should have the intellectual satisfaction of pursuing a small problem in some branch of botany at leisure. This is achieved in many departments by honours students undertaking a 'special study' or 'minor thesis' in the final year or in the preceding vacation.

The division of students into experimentalists and non-experimentalists is highly undesirable. The morphologist, taxonomist, mycologist, geneticist and ecologist, no less than the plant physiologist, must now make the experimental approach to problems. The so-called 'classical problems of morphology'' consisting in the main of theories, which cannot be tested by experiment, concerning the phylogeny of organs and of larger systematic groups, no longer command the attention of many academic botanists.

During their course honours students should have an opportunity of seeing the work of research stations and of the national museums. Students thinking of government employment as botanists should, where possible, undertake vacation work at some research institute or at a national taxonomic centre. This is becoming increasingly common.

Dr. W. O. James, F.R.S., University of Oxford

It is difficult to comment constructively on Dr. Ashby's suggestions on account of their point of departure. Honours courses in botany should not be based on his explicit assumptions that the 'bias' of the available staff may be disregarded, and that the courses are a training only for professional botanists. Botany has a much wider value in higher education than self-propagation.

We should not, I think, allow ourselves to be browbeaten by a term, even of so impeccable an appearance as over-specialization. Botany students are of many kinds, not of two only, and a degree of specialization that might poison one may be meat to another. Nothing has impressed me more than the transformation that comes over many students when they pass from the classwork stage to the specialist. The real objection to Dr. Ashby's dichotomy is that it is likely to prove impracticable and seems undesirable. Observation and experiment are still the 'Siamese twins' of botany, and the attempt to dissect them would prove dangerous to the more experimental side and perhaps fatal to the other ; much of modern taxonomy and morphology is labelled experimental. Neither does it appear probable that the training proposed for experimentalists would enable more than a few to read many modern papers on photosynthesis. Where two sciences converge, the future lies with those who are willing to co-operate on a basis of knowledge of their own discipline with respect and sympathy for the other. The biologist for the team will be more useful if he is widely trained in biology than if he is given a second-rate knowledge of chemistry and physics.

In a three-year honours course, the first year should be non-specialized in the sense that it ranges over the whole subject. Since students hate the apparent repetitions of a concentric system, it should not be a prospectus to be filled out later, but a definitive treatment of topics chosen for their relative ease of absorption. There should also be courses in methodology with round-the-bench discussion. Collateral reading should be judiciously selected, but could not, I am afraid, lean very heavily on the original publications of the great botanists. Unfortunately, the great botanists have not been great writers, and botany has yet to produce its D'Arcy Thompson.

The two subsequent years should continue with the same collateral plan, the major divisions of botany being built up side-by-side. By the end of the first year most students have discovered their preferences and should be allowed to specialize by a moderate discard of topics. In smaller departments this will inevitably be done for them by the 'bias' of the available staff. On no account should 'dead' lecturing on mugged-up material be tolerated in honours courses. If there is to be a Part I examination, it should come at the end of the second year. This plan I believe to be both more realist and more desirable than a naturalist-from-experimentalist split of the subject.

Prof. F. W. Jane, Royal Holloway College, University of London

That the honours student is committed to early specialization is incontestable ; how early, it is difficult to decide. Modern botany shows a trend toward convergence of its several branches, researches in cytotaxonomy, experimental morphology or biochemical mutants, for example, indicating an increasing synthesis of the various aspects of the subject. Precocious specialization would handicap the student in appreciating this modern approach, and he would be less likely to contribute to its progress later. Moreover, in a science which is becoming increasingly experimental, any attempt to segregate students into experimentalists and non-experimentalists seems neither practicable nor desirable. The best initial equipment for any botanist is surely some understanding of living plants, a recognition that they have form as well as function, an environment as well as a history. Early specialization would not foster this understanding.

If the supply of botanists greatly exceeds the demand, many graduates, despite specialization, are likely to become school teachers, concerned with teaching elementary botany, training in which has now been relegated from the universities to the schools. Here, surely, specialization would even prove a liability.

While the vocational aspect of a university course inevitably bulks large, it should not obscure the need for a purely intellectual training or discipline. I like the individualistic outlook of Mr. J. E. Dale : it implies, and I believe truly, that the worth-while student will follow his own bent and achieve success, in spite of, rather than because of, what his tutors may do to guide him.

Prof. Irene Manton, University of Leeds

In my view the only effective way of increasing the quality of the scientific training of botanists without imposing too early specialization, which would defeat its own ends by unbalancing the teaching in schools, is to make available such resources as are most strongly represented in our best departments to a greater range of students than is now the case. This could, I think, be done most effectively by offering a limited number of post-graduate courses of full-time study of perhaps a year's

duration, leading to a special qualification such as the M.Sc. by examination, in certain special fields with exacting technical requirements, for example, advanced plant physiology, cytogenetics or biophysics, taxonomy and/or ecology, to name a few at random, on the lines already initiated by the University of Nottingham in its postgraduate course in mycology, and by the University of Sheffield in its similar treatment of biochemistry. Such courses would precede and be the basis for the narrower and in many ways very different training in research on a specific problem which our present Ph.D. students receive.

Such courses would impose a heavy strain on departments giving them and might perhaps in certain cases be held in alternate years or be shared in some way between several strong departments. Use could also appropriately be made of departments in the Commonwealth since, for example, the University of Malaya might be better placed to offer an intensive postgraduate training in angiosperm taxonomy than a British department. Co-operation and some co-ordination between universities would be essential to prevent overlapping. Some adjustment of postgraduate financing of students would be needed, and in some universities it may be necessary to overcome prejudice against the use of higher degrees for such purposes. If these difficulties could be overcome, the technical qualifications of our best students for careers other than school teaching would be greatly enhanced without disturbance to existing undergraduate curricula.

Prof. J. R. Matthews and P. J. Faulks, University of Aberdeen

The steadily increasing content of botanical science suggests the need for a revision of the teaching curriculum, and Dr. Ashby's proposed modifications are a possible solution of a real difficulty. While too early specialization in undergraduate training is to be deprecated, provision should be made in the final year (fourth year in Aberdeen) for a student to receive specific training in a selected branch of the subject. This depends partly upon the student's real interests and aptitudes (which the good student seeking to become a professional botanist will have discovered for himself) and partly upon his proficiency in ancillary subjects.

A fair measure of specialization in the final year will at least enable the student to begin the process of fitting himself for his future career; for no undergraduate course of normal duration can expect to complete the task. Special training, however, is valuable only in so far as it is based upon a sound foundation of botanical knowledge which must be laid in the first three years. All students should receive a *general* training in morphology and physiology, and time can be saved for certain 'modern essentials' if classical theories are not elaborated in the early years. They should also derive from abundant practical illustration, rather than from formal teaching a knowledge of taxonomy, while a 'modern essential' for all students is an introduction to the design and analysis of experiments. The vocational aspect frequently influences the student's final choice of 'specialism', and it should be recognized that not every school of botany can specialize in every branch of the subject.

Prof. R. C. McLean, University College, Cardiff

Dr. Ashby's paper gives expression to a concern that has been steadily growing in the minds of teachers in recent years: how to make terms with the future. The problem can only get worse, and a solution must be found. To continue giving all students a sketch of everything, old and new, is entertaining and may broaden their minds, but it is not the way to train professional botanists. Subsequent speakers did not all appreciate Dr. Ashby's limitation of his argument to that aspect.

There are two ways to meet the situation. One is that of the mathematicians, to confine undergraduate courses to the classical aspects of the subject and leave exploration of the frontiers until the postgraduate period. Unfortunately, our frontiers are too close to us to be ignored, and the alternative obliges us to contemplate some such dichotomies of study as Dr. Ashby suggests. A canalization of interests will be forced upon the botanist as soon as he begins professional life: why not recognize this situation and prepare him for it by better (which means wider) training along the lines of his aptitudes. This is where the bias of staffs comes in—not always illegitimately, I beg to think. I am not impressed by the argument that one cannot distinguish between observational and experimental aptitudes during a student's training. Nearly forty years of university teaching has led me to the contrary opinion.

A broad preliminary course is certainly essential; but those who shake their educational heads over subsequent specialization are ignoring the immense capacity for self-teaching possessed by the good mind. It is quite possible for a physiologist to develop an intimate knowledge of the Bryophyta, for example, on no more than an elementary basis, and we could all multiply instances of men who have successfully combined specialization with broad and varied interests of their own choosing. To broaden his outlook is a man's own task; what he is taught is, happily, not the decisive factor.

Prof. P. W. Richards, University College of North Wales, Bangor

I agree with so much of what Dr. Ashby has said that I hesitate to range myself among his critics. The 'dilemma of the curriculum' faces every teacher of a rapidly growing science such as botany; but I think Dr. Ashby's solution is based on a dangerous over-simplification of the real situation. As Mr. Bell said, students do not fall into two classes only—the 'experimentalists' interested in applying physics and chemistry to plants, and the 'naturalists'. Both the needs and the aptitudes of students are more varied than that, and if we forget this and plan the botanical curriculum as Dr. Ashby proposes, we shall provide badly for many who do not belong exclusively to either class, such as geneticists, ecologists and plant pathologists. The ecologist, for example, needs training in plant physiology (except perhaps for its more 'biochemical' aspects) as much as in systematics; but how would he fit into Dr. Ashby's 'dichotomous' curriculum? My own solution would be to divide the subject not into two, but into seven or eight, branches and allow the student to specialize in a reasonable number of these.

Apart from objections in principle, I foresee great difficulties in applying Dr. Ashby's suggestion, except in a very large and well-staffed department. In one such as my own without a large staff, and in which future professional botanists form only a small minority of the students, these difficulties would probably be insuperable.

PROF. M. SKENE, UNIVERSITY OF BRISTOL

Dr. Ashby's acute analysis is very welcome. The problems arising from the increasing amount and range of knowledge are felt by all botanists. There may be less agreement on the solution suggested; indeed, it may be that no uniform plan is desirable.

In undergraduate work we should educate botanists and not train them for particular botanical jobs. All undergraduates should have the same general education. The morphologically minded should gain good experience in experimental work; the physiologist should know how to handle a variety of plants. Natural bias in ability and interest can be allowed for in the setting of the examination papers.

Botany is the meeting-ground of many sciences, and the advantage of this in a liberal education should not be lost: nor is the dichotomy so sharp as Dr. Ashby suggests. The plant pathologist is a good example of a specialist who must be competent in both fields.

The exhaustive study of a few types is valuable in giving depth; but the method should be judiciously tempered by opportunities for getting to know a large variety of material. Diversity of creatures is the essence of living Nature, and, to many, the spice of biological study.

The employers of botanists should not expect the new graduate to be ready trained for a special job. The necessity for this training remains. It would best be met by postgraduate diploma courses of about one year's duration. Such courses might well be shared out between the universities. For very many graduates they would be more useful than the years spent in research leading to a higher degree.

PROF. M. THOMAS, F.R.S., KING'S COLLEGE, NEWCASTLE UPON TYNE

The few words available may be used most economically to state present practice at King's College, Newcastle upon Tyne, in framing "honours courses in botany considered solely as a training for professional botanists (not including school teachers)", to which Dr. E. Ashby limited the scope of his address. We have been experimenting for a number of years, and realize that there is much scope for further experiment.

At present we require all honours students to study all post-intermediate courses given over two complete sessions in the Department of Botany. They all thus cover the ground for the final pass (general) examination. In their third and final year each honours student is informed that about two-thirds of the course is the maximum he can be expected to cover. Experience has shown that the combination of interests varies with the student. The special study of taxonomy has been combined with that of molecular events.

Our view is that the problem of each honours student requires individual consideration, which is extended to the selection of auxiliary subjects. We consider that some knowledge of chemistry is desirable for all; but chemistry is not a compulsory subject. Intending physiologists often extend their chemical studies over two years. As regards our other specializations, zoology has been the most favoured subject for two years of study by intending cytogeneticists and field ecologists. Bacteriology has been studied with much profit by students now carrying out graduate research in mycology. Students having the necessary mathematical ability have been encouraged to study physics above an elementary level.

More than ten years ago two students of special honours quality graduated in what might be regarded as a joint honours school in physics and botany, and another student in chemistry and botany. Unfortunately these combinations of subjects have not been taken in recent years. A case could be made for such schools rather than special honours in botany for certain picked students competent to study physical as well as biological science to a high level.

PROF. T. G. TUTIN, UNIVERSITY COLLEGE, LEICESTER

I cannot altogether agree with Dr. Ashby that the solution of our difficulties lies in earlier specialization. Taxonomists and morphologists are at last applying experimental methods to their studies, and some knowledge of mathematics, physics, chemistry and plant physiology is essential if they are to make real progress.

It is of particular importance in this connexion that the chemistry which botanists learn should include more physical and organic chemistry and less about the lead-chamber process.

For a sound training in botany a four-year course seems desirable to-day, if financial considerations will permit it; the first two years can then be spent on a general course in three subjects, chosen in accordance with the special interests of the student, the next year on a wide botanical course and the final year in specializing in a particular part of the subject. Recent experience here has clearly demonstrated the great value to the student of being able to spend four years over the degree course. The acceptance by many universities of the General Certificate of Education at Advanced Level as a substitute for Intermediate greatly increases the desirability of a four-year degree course, since students often arrive at the university with little real foundation for their subsequent studies.

A less satisfactory, though perhaps more practicable, alternative might be to retain the three-year course with a less detailed treatment of the groups of cryptogams in the first two years and then to allow considerable specialization in the final year.

Finally, would it be unkind to suggest that the pure "naturalists" with no aptitude for experiment or interest in physical sciences should be encouraged to take an arts degree and pursue botany as a hobby?

PROF. D. H. VALENTINE, DURHAM COLLEGES IN THE UNIVERSITY OF DURHAM

I am in general agreement with Dr. Ashby's proposals; but I would suggest some modifications. First, I do not think an honours student should choose his subject until, at earliest, the end of his first year at the university; it is not uncommon for a student to change his mind about his subject, and I think it is well that he should be able to do so. Secondly, I think that it is most undesirable to widen the division between botany and zoology, as Dr. Ashby seems to suggest. On the contrary, I think the subjects should, so far as possible, be brought closer together. Thus, I should like to make it possible for students who have had a good introductory training in both disciplines to specialize in their final year in, say, evolutionary studies, or animal and plant ecology, or cell physiology; the courses would be provided jointly by both botany and zoology departments, with assistance from other departments where it was required.

Prof. W. T. Williams, University of Southampton

I strongly support Dr. Heslop Harrison. There is room for a continuous spectrum of botanists, ranging from the pure morphologist to the biochemist, and it is the traditional task of any one of these to bring his chosen problem one stage nearer to the realm of the chemist. The rigid segregation of students into two groups, whatever its organizational advantages, might easily result in morphologists who are not interested in the physiological problems underlying their study, and in physiologists who are largely unaware of the vast fields of experimental morphology awaiting investigation. If a student genuinely wishes to specialize early, encourage him; but let us at all costs attempt to retain the possibility of training good general botanists, however difficult this may be.

OBJECTIVITY OF COLOUR PREFERENCES

By Dr. G. W. GRANGER

Psychology Dept., Institute of Psychiatry, Maudsley Hospital, London, S.E.5

IT has long been supposed that colour preferences are entirely a matter of personal taste, depending on individual associations and other subjective factors, and the results of numerous experimental studies have seemed to support this view. Thus, Chandler[1] in his survey of research on colour preferences remarks that the results of these experiments are "chaotic"; the most careful and thorough work of such acknowledged authorities as von Allesch[2] serves only to emphasize the fact that observers disagree sharply as to the relative preferential value of single colours and colour combinations.

This apparent lack of agreement has led those psychophysicists and sensory psychologists who have explored in great detail the 'objective' stimulus dimensions of colour to dismiss the æsthetic, affective or preferential values of colours as purely subjective and outside the scope of present-day scientific analysis. For quite different reasons, æstheticians and psychologists of *Gestalt* persuasion have declared the whole realm of colour æsthetics to be beyond analysis by the ordinary atomistic and dimensional methods of science. Such writers argue that this field is characterized by "emergent properties" which cannot be accounted for in terms of parts and relations between parts as Spearman[3] and other elementalists have claimed; at every turn the investigator is confronted by *Gestalt* or whole qualities that defy analysis.

Recent experiments by the author suggest that neither of these two extreme views, the subjective nor the *Gestalt*, is justified; indeed, the evidence seems overwhelmingly in favour of objective and fairly atomistic hypotheses. As detailed accounts of the individual experiments on which this evidence is based will be published elsewhere, only a general summary will be presented in this paper.

In the first experiment, sixty sets of standard Munsell colours were selected to represent the entire colour solid along its three principal dimensions: hue, lightness and saturation. Within each set the colours were ranged in order of preference by fifty subjects (twenty-five men and twenty-five women) of normal colour vision, as tested by the Ishihara[4], Rabkin[5], and Farnsworth–Munsell[6] tests. Illumination at 6,500° K. was provided by a specially calibrated tungsten lamp in conjunction with a Macbeth daylight filter, and the colours were viewed against a neutral grey background of Munsell value 5. When subjects' rankings were summed for each set and the amount of agreement calculated in terms of Kendall's[7] coefficient of concordance (W), it was found that the resulting coefficients reached significance at the $P < 0{\cdot}01$ level, indicating quite clearly that the subjects were not independent in their preferences; on the contrary, they showed a remarkable degree of concordance, the average value of W being about 0·3. Further, it appeared that the general order of preference for any one attribute of colour (which remained invariant at different levels of the colour solid) was dependent on stimulus properties in the following way: hues of shorter wave-length tended to be preferred to those of longer wave-length, the more saturated colours were preferred to the less saturated, and colours which contrasted least in lightness with the background were ranked higher than colours showing maximum contrast. Conclusions were necessarily tentative, owing to the small number of items involved in the general order of preference. Contrary to some earlier claims, no marked differences were found between the preferences of men and women.

A second experiment was undertaken in which preference judgments were obtained from twenty subjects for four sets of colour combinations. Three of the sets represented variation along each of the principal dimensions of colour, while the fourth contained fully saturated hues which had been used in a previous experiment by Clarkson, Davies and Vickerstaff[8]. Preference judgments for the hue, lightness and saturation tests were obtained against a background of neutral grey, while preferences for the combinations of fully saturated hues were obtained against a black background to facilitate comparison with the previous research in which this type of ground had been used. Data for all four tests were collected, as in the first experiment on single colours, under an approximation to C.I.E.[9] illuminant *C*. When subjects' preferences were analysed, it was found once again that a large measure of general agreement existed for all four types of colour combination used in the experiment, and, as before, the general order of preference seemed to be dependent on objective stimulus properties: thus, preference tended to increase with increasing hue distance between the component colours making up the combinations, to decrease with increasing lightness, and to decrease with increasing saturation. This dependence was most striking in the case of hue combinations, where there was an almost perfect positive correlation between preference judgments and the size of hue interval between the components. Particularly encouraging was the independent confirmation of results obtained earlier by Clarkson, Davies and Vickerstaff. From data kindly supplied by Dr. T. Vickerstaff, it was possible to calculate correlations between preference judgments and hue interval, and when this was done, the resulting coefficients exceeded 0·95—somewhat larger than those I have obtained for combinations of fully saturated hues.

Finding that preferences for combinations of hues could be accounted for almost entirely in terms of

* Substance of a lecture to the Colour Group of the Physical Society delivered on February 13.

the interval between the component colours in the case where one component remained constant for a given series, it was decided to consider the more general case in which not only the interval or relation between the components varied from one combination to another, as in the second experiment, but also in which the component colours were both allowed to vary throughout a given series. Could preference be accounted for at this more complex level? Moon and Spencer[10], two recent theoretical writers on colour harmony, have claimed that such prediction is possible and, on the basis of certain assumptions concerning the various classes into which harmonies can be divided and Birkhoff's[11] work on 'æsthetic measure', they have developed an 'æsthetic formula' for colour combinations. Unfortunately, this formula, like its earlier counterpart for polygonal figures, leans too heavily on deductive procedures which fail to take into account results of empirical research in æsthetics: in consequence, when submitted to experimental test, its predictive value proved to be negligible. However, a simpler formula, derived not from assumed higher principles but from the results of previous experimental work on 'hedonic summation' and colour harmony, was found to account for the major part of the variance (70 per cent) without taking into account the lack of perfect reliability in the subjects' preference judgments. This formula, conceived along frankly atomistic lines, depended upon two sets of factors: (1) preference for the component colours, plus (2) a relational term concerning the combination as such; in Spearman's words, upon 'fundaments' and the 'relation' between them.

Further evidence of the objectivity of colour preferences was found in experiments on the influence of background and area. It will be remembered that the experiment on the general order of preference for single colours was carried out under one background condition, namely, a neutral grey of Munsell value 5. But it cannot be assumed without proof that a general order of preference occurring under one condition of background will remain invariant under other conditions. Observation suggested that the order would remain relatively constant only when the general colour–ground relationship was unchanged. Experimental tests of this hypothesis were made using several different achromatic and chromatic backgrounds and, in general, the evidence tended to support it. Further, it was possible not only to predict *when* a significant change in preference would occur, but also, to some extent, the direction it would take, on the basis of results obtained earlier in the experiments on preferences for single colours and colour harmony. As before, there was a substantial measure of agreement between subjects' preferences.

The influence of area was studied in relation to colour harmony. The importance of this factor is generally recognized both by æstheticians and practising artists, who often claim that ". . . the choice of quantity is more important than the choice of colour"[12]. From the practice of artists, an empirical 'rule' has developed concerning the proper balance of areas in a colour design: the accepted principle is that a large area of colour at a low degree of saturation will balance a small area of highly saturated colour; the principle is sometimes extended to lightness—balancing of the darks against the lights. When stated in quantitative terms, this principle is of particular interest to experimental æsthetics, and my experiments were designed to test the predictive value of two 'formulæ' that have been proposed. The first formula was developed by A. H. Munsell[13], founder of the Munsell colour system, who stated his 'rule' for area balance in the following way: ". . . the stronger the color . . . the smaller must be its area; while the larger the area, the grayer the Chroma. Thus *R* 7/6 balances *R* 3/3 in the proportion of nine parts of the lighter red to forty-two parts of the darker red. In other words, these symbols will balance colors inversely as the product of their factors". The second formula, proposed by Moon and Spencer[14], is rather more elaborate; these authors claim that a pleasing balance is obtained when the product of each area and its distance from the 'adaptation point' in colour-space is the same. The colour-space to which they refer is a metric-space, developed by making a mathematical transformation of the C.I.E. colour-space.

In order to test these two hypotheses, pairs of Munsell colours were presented to a group of subjects, who were asked to adjust the areas of the two colours in each pair to give the most pleasing balance. Results showed, first, a large amount of concordance between subjects' preferences and, secondly, the superiority of Munsell's empirical 'rule' over Moon and Spencer's formula: whereas Munsell's formula accounted for about 40 per cent of the total variance, Moon and Spencer's gave very small and insignificant correlations between observed and predicted preferences.

Finally, an attempt was made to link results of some of the experiments on colour appreciation with preferences for more complex visual material. The method adopted was first to derive 'scores' for subjects who had taken part in the experiments on preferences for single colours and colour harmony by correlating individual preferences with the general order of preference (a procedure for which justification has previously been given by Eysenck[15] and other investigators of general æsthetic appreciation), and then correlating these scores with scores on the Maitland Graves test of design judgment[16], which involves the ranking of black-and-white designs. Both correlations, between preferences for single colours and design judgment, and between preferences for colour combinations and design judgment, were significant and fairly high, being 0·60 and 0·73, respectively. Although based on a small number of cases, these positive correlations suggest that preferences for elementary colour stimuli may be dependent on an æsthetic factor of a fairly comprehensive kind; they also do something to counter the assertion, often made by theoretical æstheticians, that the experimental æsthetics of simple sensory stimuli has no bearing on the problem of æsthetic appreciation, especially as the design judgment test used in this experiment has been shown to have a considerable degree of validity when measured against acceptable external criteria.

The main conclusion which seems to follow from the results of these experiments is that colour preferences are objective in the sense that (*a*) they are to a considerable extent independent of personal taste, and (*b*) are dependent to some degree on inherent stimulus properties; there is no experimental justification for an extreme subjectivist point of view in this field. This suggests that preferences rest on a firm biological foundation in the perceptual equipment of the individual, and such an interpretation gains support from the re-analyses made first by Eysenck[17] and later by me (using different

statistical techniques) of data on the colour preferences of subjects from widely different backgrounds and even from different culture patterns: the evidence everywhere indicates a substantial measure of agreement. Results show quite convincingly that the conclusions reached by von Allesch, Chandler and others, and referred to earlier in this paper, were not warranted by their own data; they were arrived at on the basis of inadequate statistical procedures. Finally, there seems to be no justification for an extreme *Gestalt* point of view in this field, for preferences can be accounted for in terms of quite atomistic concepts of relations and fundaments, and knowledge derived from elementary colour stimuli can be applied to preferences for material of a more complex nature. The value of this demonstration may extend beyond the realm of experimental æsthetics to other parts of the psychological field in which problems of organization are encountered; thus, the relevance of these studies to the problem of personality organization has already been considered by Eysenck in a recent publication dealing with "The Scientific Study of Personality"[18].

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OBITUARIES

Dr. W. T. Calman, C.B., F.R.S.

William Thomas Calman, who died suddenly on September 29 in his eighty-first year, was a great zoologist. A distinguished pupil of the late Sir D'Arcy Thompson, he was well known as the leading British carcinologist of our time, author of the volume on "Crustacea" in Lankester's "A Treatise on Zoology" (1909) and of "The Life of Crustacea" (1911).

Born at Dundee in 1871, Calman was educated at the High School and, after a spell as clerk in an insurance office, at University College, Dundee (later to become one of the constituent colleges of the University of St. Andrews). On obtaining his B.Sc. in 1895 he was appointed assistant lecturer and demonstrator in zoology, a post which he held until 1903, taking his doctorate in 1900. There he acquired valuable teaching experience and a sound knowledge of zoology which many learned to appreciate in later years.

When he joined the staff of the British Museum (Natural History) in 1904, he was placed in charge of the Crustacea—a group which he had already made his own—and the Pycnogonida, and for a short time he was responsible for the Arachnida as well. In addition to his official duties, he for many years compiled the Arachnida and Crustacea sections of the *Zoological Record*, and it was astonishing how well he remembered references twenty or thirty years later. In 1921, the year in which he was elected to the Royal Society, he became deputy keeper of the Department of Zoology, and in 1927 he succeeded Regan as keeper, a post which he held until his retirement in 1936. In the previous year he had been created a C.B., and in 1937 was elected an honorary Fellow of the Royal Society of Edinburgh.

Calman also took a prominent part in scientific activities outside the Museum. He served on the Council of the Royal Society and as external examiner to several universities. For twenty-seven years he was secretary to the Ray Society, and at the time of his death was an editor of the *Annals and Magazine of Natural History* and a member of the International Committee on Zoological Nomenclature. His longest association was with the Linnean Society of London, of which he was zoological secretary (1923–28), president (1934–37) and Linnean Gold Medallist. At the 1930 Bristol meeting of the British Association he presided over Section D (Zoology).

In a presidential address to the Quekett Microscopical Club, Calman tells us that he was an amateur microscopist before he began the serious study of zoology. D'Arcy Thompson chanced to hear him speak on rotifers and, recognizing his aptitude, made it possible for him to enter the University. After graduation he turned his attention chiefly, though by no means exclusively, to the Crustacea. From 1896 onwards he contributed a steady stream of papers of the highest order. His work impresses not so much by its quantity—several of his contemporaries were more prolific writers—as by its intrinsic qualities. These are already apparent in his earliest papers, notably that in which he demonstrated with remarkable insight the affinities of the recently discovered *Anaspides* with the fossil Syncarida. They appear at their best in the "Treatise" volume which all specialists regard as his masterpiece. The book is much more than a lucid, concise, masterly synthesis of what was known at the turn of the century. Calman possessed, to a degree that has rarely been equalled, a gift for winnowing the significant from masses of detail. He revealed much of the order beneath the diversity of the subclass Malacostraca; the new classification which he introduced in a small paper published in 1904 was accepted, and, with the addition of the small order Thermosbænacea to the division Peracarida, still stands. Much of his later work was concerned with the elucidation of the more obscure orders of the Malacostraca and with the phylogeny of the Arthropoda. He also wrote on marine boring organisms injurious to submerged structures, and on the Pycnogonida.

Calman had hoped to continue his research work after his retirement, and did, in fact, report on the Pycnogonida and Caridea of the *John Murray* Expedition. Later, however, he moved to Tayport, Fife, and soon we find him acting as temporary wartime lecturer in zoology in his own Alma Mater, of which he was an LL.D. A series of lectures delivered

to his students on "The Classification of Animals" appeared in book form in 1949.

As administrator of a large museum department, subordinates of all grades found him most approachable. To the younger zoologists of his staff he gave freely of his time, knowledge and experience, and as an editor he excelled. Sociable by nature, he liked to meet all visitors to his Department, whether student or foreign specialist (with whom on occasion he had to converse in Latin). All who knew him appreciated his profound erudition, his great personal charm and his sense of humour. His memory is held in affectionate esteem by all who came under his influence.

In 1906 he married Miss Alice Donaldson, of Tayport, who, with a son and a daughter, survives him.

I. GORDON

Prof. F. C. Lea, O.B.E.

PROF. F. C. LEA, emeritus professor of engineering in the University of Sheffield, died on September 30 at the age of eighty-one.

Frederick Charles Lea was born near Crewe and was apprenticed in the Mechanical and Electrical Departments of the London and North Western Railway. He received his scientific education at Owens College, Manchester, and the Royal College of Science, London. He was Senior Whitworth Scholar in 1896. After a further period with the London and North Western Railway, he became in 1900 senior assistant to Prof. W. C. Unwin at the City and Guilds of London Central Technical College. In 1908 he published the text-book on "Hydraulics" by which his name became known to engineering students all over the world. During 1911–13 he served as one of H.M. inspectors of technical education and in 1913 was appointed professor of civil engineering in the University of Birmingham.

During the First World War he held commissions, first in the Territorial Force and afterwards in the R.N.V.R. and in the R.A.F. He made a special study of materials for aircraft and was concerned in the development of all-metal aeroplanes.

In 1923 Prof. Lea was appointed professor of mechanical engineering in the University of Sheffield, and was dean of the Faculty of Engineering until his retirement in 1936. During this period he carried on experimental research, in association with a succession of students, in several fields related to the mechanical properties of metals, and he published numerous papers on such subjects as fatigue, embrittlement, welded joints, springs, and notably creep at high temperatures.

During his career, Lea took a lively interest in scientific and technical societies, and was perhaps specially attached to the British Association and to the Institution of Mechanical Engineers. He was president of Section G (Engineering) of the former in 1929 and of the Institution in 1944. He served on many committees and consultative bodies concerned with technical and educational matters, and had a considerable part in the development of the National Certificate schemes. During 1936–50 he was a director of Edgar Allen and Co., Sheffield.

Lea's contribution in the field of engineering science was a dual one: on one hand, he was a skilful and energetic experimental investigator with a wide range of interests; on the other, he was a progressive technical educationist and a particularly able teacher. His influence to-day is probably mainly felt through the hundreds of engineering graduates to whom he communicated enthusiasm and the spirit of inquiry.

In his personal life, Lea was a deeply religious man and had a high sense of social duty. Throughout his life he was an active member of the Methodist Church, and he served it in many capacities both in administration and as teacher and speaker. For several years he presided over the Sheffield Council for Social Service.

Mr. Peter Doig

WE regret to announce the death on October 13, after a long illness, of Mr. Peter Doig. He was born in 1882 in Glasgow, where he received his primary education and later he was trained as a draughtsman at the shipyard of John Brown and Co., Ltd., at Clydebank. He then worked at Harland and Wolff's, Belfast, and afterwards at shipyards in Shanghai, where a serious breakdown in health in 1916 necessitated a temporary rest, and he returned to Clydebank, travelling by the Trans-Siberian Railway to Europe. After working for a time at Beardmore's, he went to the United States, and on his return was appointed in 1918 general secretary of the Association of Engineering and Shipbuilding Draughtsmen. He did very good work on screw propeller design, on which he had specialized; but unfortunately ill-health compelled him to retire from the secretaryship of his Association in 1945.

Doig was a keen astronomer, and was elected a member of the British Astronomical Association in 1921 and a Fellow of the Royal Astronomical Society the following year. In 1930 he was appointed editor of the *Journal of the British Astronomical Association*, a position which he held until 1937, when the pressure of work with his professional Association compelled him to resign; but in 1948, after his retirement as secretary of his Association, he was re-appointed editor of the *Journal* and continued with this work until his death. He was an excellent editor, and made considerable contributions himself to the *Journal* in the form of reviews and notes from numerous astronomical publications in various parts of the world. During 1928–41 he was also honorary curator for the British Astronomical Association. In 1927 his book, "An Outline of Stellar Astronomy", was published, and an enlarged and revised edition appeared in 1947; in 1950 "A Concise History of Astronomy" was published, a book which deals with the history of astronomy from the earliest times up to recent years. During 1951–52 he collaborated with eleven other astronomers—each an authority in his own particular subject—in the production of a work on astronomy in which he was responsible for the larger portion of the chapter on the historical side and sole author of the chapter on the stars; he had corrected the paged proofs shortly before he died.

In 1909 Mr. Doig married Mary Scott, who, with a married daughter, survives him.

WE regret to announce the following deaths:

Prof. J. G. Lawn, C.B.E., president in 1930 of the Institution of Mining and Metallurgy, on October 21, aged eighty-four.

Prof. Ernest Vessiot, member of the Mechanics Section of the Paris Academy of Sciences and formerly director of the École Normale Supérieure, Paris, on October 17, aged eighty-seven.

NEWS and VIEWS

Nobel Prize for Physiology and Medicine for 1952 : Prof. S. A. Waksman

The Nobel Prize for Physiology and Medicine for 1952 has been awarded to Prof. Selman Abraham Waksman, professor of microbiology and head of the Microbiology Department of the College of Agriculture and Experiment Station at Rutgers University, New Brunswick, N.J., for his discovery of streptomycin, the first effective antibiotic against tuberculosis. Prof. Waksman was born in 1888 in Priluka, a small town in the Ukraine, emigrated to the United States in 1910 and became a naturalized citizen there in 1915. The whole of his scientific life since 1911 has been spent at Rutgers University and has been devoted to the study of microbiology, and particularly to that group of soil micro-organisms which are frequently spoken of as ray fungi and belong to the genus *Actinomyces* or *Streptothrix*. Following the discovery of penicillin, which is fully effective only against Gram-positive bacteria, Waksman and his collaborators began, in 1939, a systematic search for an antibiotic active against Gram-negative bacteria and found it, in 1944, in streptomycin, a metabolic product of *Streptomyces griseus* (formerly known as *Actinomyces griseus*). They also showed that streptomycin is highly active *in vitro* against *Mycobacterium tuberculosis*. This observation was quickly followed by the proof by Feldman and Hinshaw that streptomycin exerts a powerful suppressive action in experimental tuberculosis in guinea pigs, and finally by the demonstration by many investigators of its effectiveness in the treatment of different types of tubercular infections in man. Thus, in spite of some imperfections, streptomycin offered the first real hope of chemotherapeutic treatment of a disease which was formerly almost universally fatal.

G. A. Mantell, F.R.S. (1790–1852)

Gideon Algernon Mantell, who died a century ago, on November 10, 1852, belongs to that interesting band of medical men who have won both fame and popular applause in extra-professional pursuits. Son of a Lewes shoemaker, he was born on February 3, 1790. After serving as apprentice to a local surgeon and studying at St. Bartholomew's Hospital, London, he qualified M.R.C.S. in 1811 and thirty-two years later was elected one of the original three hundred Fellows of the Royal College of Surgeons. A busy medical practitioner in Lewes and the surrounding countryside, Mantell made many valuable contributions to geology, collecting specimens from the chalk around Lewes and from the Sussex Weald, sending reports to the Linnean Society, and building up a private geological museum, which he later sold to the British Museum for £5,000. A pioneer in the study of fossils at a time when this was regarded as impious, he is known for his discovery in the sandstone of Tilgate Forest of the iguanodon, which he reported to the Royal Society in 1825. A popular lecturer and a facile writer, his works, some of which went through several editions and were illustrated by plates engraved by his wife, include "The Fossils of the South Downs" (1822), "Thoughts on a Pebble" (1837) and "The Wonders of Geology" (1838). Mantell played a leading part in securing a free pardon for Hannah Russell in the Burwash case, and published his "Observations on the Medical Evidence Necessary to Prove the Presence of Arsenic in the Human Body" (1827). He was elected to the Royal Society in 1825 and was awarded a Royal Medal in 1849; he received the honorary LL.D. of Yale University in 1834. A victim of extreme lateral curvature of the spine, which made him hypochondriacal and acrimonious, Mantell died of an overdose of opium.

British Museum (Natural History) : Appointments

The Trustees of the British Museum have promoted Mr. Wilfred Norman Edwards, keeper of the Department of Geology at the British Museum (Natural History) to the rank of deputy chief scientific officer, with effect from December 1; Mr. Edwards will continue to hold the keepership of geology. The Principal Trustees have also appointed Dr. Frederick Allan Bannister to be keeper of the Department of Mineralogy; and Mr. Alexander Cockburn Townsend to be deputy keeper in charge of the Library of the British Museum (Natural History) both with effect from December 1. Mr. Edwards was a scholar of Christ's College, Cambridge, where he took first-class honours in the Natural Sciences Tripos in 1911. He entered the Museum in 1913 and has been keeper of the Department of Geology since 1938. He has specialized in fossil plants. Dr. Bannister was educated at Clare College, Cambridge, and took a first class in both parts of the Natural Sciences Tripos in 1922 and 1923. He entered the Museum in 1927 as an assistant keeper and has specialized in the analysis of mineral structure by means of X-rays, in the development of which method he has taken a leading part. Mr. Townsend was educated at Shaftesbury Grammar School, St. Paul's School and Magdalene College, Cambridge. He obtained second-class honours in the Classical Tripos in 1926 and in the Modern Languages Tripos in 1928. He entered the service of the Trustees in 1930. During 1931–39 he was honorary secretary of the University and Research Section of the Library Association, and since 1948 has been honorary secretary and editor of the Society for the Bibliography of Natural History.

Groundnuts Scheme in East Africa

In the House of Commons on October 29, a written reply was given to a question by Mr. A. R. Hurd asking the Secretary of State for the Colonies if he was satisfied, after another season's operations at the Kongwa, Urambo and Nachingwea centres of the East African groundnut scheme, that the large-scale experimental development proposed in Command Paper No. 8125, January 1951, was practicable; and if the policy and financial provisions then decided for the scheme had been adopted by the Government. Mr. J. G. Foster, Under-Secretary for Commonwealth Relations, stated that neither the board and chairman of the Corporation nor the Secretary of State is satisfied with the scheme as laid down. The experimental data which it was the object of that scheme to provide can certainly be obtained; but the board considers that there are fundamental agricultural problems in Urambo and Nachingwea which should be worked out on a lesser scale. The board is considering revised plans for this purpose which will keep the cost within the balance remaining of the £6 million. These should be available by December and the Secretary of State will then make a further statement.

Cartographical Needs of the Airman

THE activities of the Institute of Navigation include the investigation of various problems by working-parties under the general guidance of the technical committee, and several of these were referred to by Rear-Admiral A. Day, Hydrographer of the Navy, in his presidential address to the Institute. One working-party has undertaken to inquire into the precise requirements the airman needs of his maps and charts. The nautical chart has been built up to its present shape by many centuries of knowledge and experience of what the seaman wants. The air chart, like aviation itself, has grown up quickly, so that just what it should be like and exactly what is wanted of it has not been so easy to establish without question. The basis from which the Institute's working-party proposes to begin its investigations is one that accepts air navigation as it is to-day, but does not necessarily relate it to a system which uses charts in their present form. This means that their examinations will go much deeper than merely questioning whether, say, a map used for aircraft operating at a height of some 40,000 ft. should give the characteristics of lighthouses, or should show the 100-fathom line. Another problem is how to determine the quickest flight-path from one place to another, a problem which bears directly on the economy and efficiency of navigation in long-distance flights. A workable method of being able to determine, for any given set of meteorological conditions, the route of least time would be of considerable assistance to air operators. For some time now the Institute has had a working-party investigating the whole problem of determining the optimum flight-path; the task is a long one, partly because the aim is to produce a practical method which will offer clear advantages over those used in flight-planning to-day.

Oil in Pakistan

A SPEECH on the development of the oil industry in Pakistan was recently given in Karachi by M. J. Condon, chairman of the board of directors of Pakistan Petroleum, Ltd. The sole producing region is the Potwar Basin, south-west of Rawalpindi, where four fields are established—Khaur, Dhulian, Balkassar and Joya Mair—but production is relatively small. Exploration is, however, active, six major tests being in operation at Bains and Chak Naraung in Punjab, at Sui in Baluchistan, at Patharia and Sylhet in East Bengal, and at Patiya near Chittagong. Mr. Condon's forecast on these prospects does not, however, appear particularly optimistic. As he rightly points out, prospecting costs in Pakistan are fifteen times what they are in the United States, primarily because all plant and equipment has to be shipped to the former country from overseas whereas "in America these things are available to the end of a telephone line", a pertinent comment on petroleum economics in other countries besides Pakistan. There is the prospect of a refinery being erected in Karachi, and a technical commission is being set up to review the whole situation. It is clear that the Pakistan Government and the industrial enterprises concerned are doing everything possible to develop petroleum resources in this geologically difficult territory.

An Atlas of the Asclepiadaceæ

UNDER this title, and with the help of some seventeen maps, Prof. R. GOOD (*New Phytologist*, **51**, 198; 1952) has illustrated the distribution of the family, sub-families, tribes and selected genera of this highly distinctive group of tropical plants. The Asclepiadaceæ, by some taxonomists included in the order Apocynales, include perennial herbs, undershrubs, shrubs and climbers, all having a specialized pollen-transfer mechanism. Because of their particular and highly unusual features, the two constituent sub-families thus afford very useful materials for geographical study. The maps represent a summation of all available information regarding the distribution of the family. The family has a general distribution both in the Old and New World tropics, and of its two sub-families the smaller is confined to the Old World, while the larger is present in both hemispheres. The family, however, is poorly represented in isolated islands. The proportion of narrowly distributed or endemic genera is very high, some being very local; that of endemic species is even higher, no such species being common to both worlds.

A New Circumpolar Plant Species in Scotland

WITH the discovery in 1951 of *Diapensia lapponica* L. (Ericales) at 2,500 ft. in the Arisaig district of Inverness-shire, Scotland, a new species, genus and family have been added to the British flora. Several hundred specimens have now been observed in this locality, the habitat being completely exposed, on stony and gravelly schists, and with a rainfall of 120 inches. *D. lapponica* is one of the small group of circumpolar, arctic-montane species—a group not represented in the mountains of Central Europe—with a wide distribution in the several continental and insular areas in the Arctic region (see J. Grant Roger, "*Diapense lapponica* in Scotland", *Trans. Bot. Soc., Edin.*, **36**, Pt. 1, 34; 1952).

N.P.L. Colour Temperature Scale

IN July of this year the Director of the National Physical Laboratory announced that in future the 1948 International Temperature Scale would be used in assigning colour temperatures to light sources calibrated at the Laboratory. Previously, the 1927 International Temperature Scale had been used. The Laboratory has now issued the following comparisons and conversion factors. Corresponding values of temperatures on the two scales, in the range of importance in the calibration of tungsten filament lamps, are as follows:

1927 Scale	1948 Scale
1500·6° K.	1500° K.
2003·8	2000
2508·6	2500
3015·1	3000
3523·7	3500

If a lamp has been found by calibration to give a particular value of colour temperature on the 1927 Scale when it is run at a certain voltage V, the voltage to give the same numerical value of colour temperature on the 1948 Scale is obtained by multiplying V by the factor shown in the following table:

Colour temperature (° K.)	Multiplication factor for voltage
1500	1·001
2000	1·005
2500	1·009
3000	1·014
3500	1·019

These factors may be taken as correct to about one-tenth of one per cent.

Illuminant A. The factor by which the voltage of a lamp calibrated at 2848° K. on the 1927 Scale must

be multiplied to give 2854° K. on the 1948 Scale (the current definition of colorimetric illuminant *A*) is equal to 1·018.

Scottish Postgraduate Scholarship Awards in Agriculture

The Department of Agriculture for Scotland has awarded the following postgraduate scholarships in agricultural subjects, tenable for periods up to three years, commencing October 1 at the university or institute shown: *Agricultural Economics*, A. V. Vickery (Agricultural Economics Research Institute, Oxford); *Husbandry*, J. Eadie and A. O. Ballantyne (continuation of current award) (University of Edinburgh), D. S. Hay and R. R. Shepherd (University of Cambridge), R. Laird and T. D. MacLean (University of Reading), and A. F. Gristwood (continuation of current award) (Ohio State University); *Statistics*, St. C. S. Taylor (continuation of current award) (University of Edinburgh).

University of London

The following announcements have recently been made from the University of London: the title of reader in mechanical engineering has been conferred on H. Hampson in respect of the post held by him at Queen Mary College; the degree of D.Sc. has been conferred on Miss Olive N. Purvis (Imperial College of Science and Technology) and C. A. Rogers (University College).

University of Leeds

The University of Leeds has conferred the title of emeritus professor upon Prof. J. W. McLeod on the occasion of his retirement from the Brotherton chair of bacteriology. The following have been appointed lecturers in the University: Dr. R. W. Owen (zoology), F. R. Mobbs (mechanical engineering), and G. Hay, G. W. Reed and Miss Margaret T. Morrison (medical physics).

Fourteenth International Congress of Zoology, Copenhagen

The Fourteenth International Congress of Zoology will be held in Copenhagen during August 5–12, 1953, under the presidency of Prof. R. Spärck, with Dr. Anton Fr. Bruun as secretary-general. It is proposed to hold three general meetings for all members of the Congress; but otherwise the proceedings will be divided into various sections, each dealing with specialized topics. Two excursions to West and East Jutland have been planned after the Congress, and possibly a third one to study marine fauna of the deeper part of the Skagerrak; no excursions will take place before August 5. Membership fee for the Congress is 100 Danish kroner (approximately £5 5*s*. or 15 dollars).

Conference on Race Problems

The British Social Biology Council is holding a one-day conference on Saturday, December 6, on race problems. The subject will be approached from three angles: the biological, the psychological and the anthropological. The main speakers will be Dr. A. F. Mourant, Dr. Kenneth L. Little, W. R. Bion and M. Freedman. Chairmen will include Dr. Julian Huxley and Dr. B. W. Gussman. The conference will be held in the Chemistry Lecture Theatre at University College, London, and tickets can be obtained from the Secretary, British Social Biology Council, Tavistock House South, Tavistock Square, London, W.C.1, price 7*s*. 6*d*. (or 5*s*. for students whose applications are endorsed by some person of suitable status).

Announcements

H.R.H. The Duke of Edinburgh will open the new wing of the Department of Engineering in the University of Cambridge on November 13.

Sir Harry Garner, chief scientist to the Ministry of Supply since 1949, is to retire early next year. He will be succeeded by Dr. O. H. Wansbrough-Jones, principal director of scientific research (defence) in the Ministry since January 1951 and formerly scientific adviser to the Army Council (see *Nature*, 157, 688; 1946).

At the opening session on October 4 of the academic year at the University of Liège, the degree of doctor of medicine *honoris causa* was conferred on Prof. Réné Fabre, doyen of the Faculty of Pharmacy, University of Paris, and on Prof. D. Keilin, director of the Molteno Institute, University of Cambridge.

The third meeting of the European Association of Exploration Geophysicists will be held in the Stadthalle, Corvinusplatz 2, Hannover, during December 4–5, the business meeting being held the previous evening. Twenty papers from various European countries will be presented as follows: nine on seismic, seven on gravity, one on magnetic, two on telluric and electrical, and one on radioactivity methods of prospecting. Further particulars can be obtained from the secretary/treasurer, Dr. B. Baars, 30 Carel van Bylandtlaan, The Hague, or from Dr. D. T. Germain-Jones, Kirklington Hall, Nr. Newark, Notts.

Under the provisions of the Fulbright Programme, travel grants are available to citizens of the United Kingdom and British Colonies to go to the United States for academic or educational purposes, provided that they have the financial support in dollars for the visit and are affiliated to an American institution of higher learning. The grants cover the cost of direct travel from the candidate's home to America and return, and are available during June 1, 1953–May 31, 1954. Applications must be submitted by March 16, 1953 (those travelling between June 1 and July 31) or June 15 (those travelling after August 1). Further information can be obtained from the United States Educational Commission in the United Kingdom, 55 Upper Brook Street, London, W.1.

In a notice of the *Journal of Scientific Instruments* published in *Nature* of August 23, p. 298, it was remarked that: "When the *Journal* was started in 1923 it was the only periodical devoted to . . . scientific instruments". Mr. L. B. Tuckerman, of the National Bureau of Standards, Washington, D.C., points out that the first issue of the *Journal of the Optical Society of America and Review of Scientific Instruments* appeared in January 1922, and that the *Zeitschrift für Instrumentkunde* was a well-established journal by 1923, having been started in 1881.

The new photoelectric absorptiometer referred to in *Nature* of October 25, p. 694, is manufactured and sold by the Hilger Division of Hilger and Watts, Ltd., 98 St. Pancras Way, Camden Road, London, N.W.1.

THIRD INTERNATIONAL SYMPOSIUM ON THE CHEMISTRY OF CEMENT

A SYMPOSIUM on the chemistry of cement, sponsored jointly by the Building Research Station of the Department of Scientific and Industrial Research and the Cement and Concrete Association, took place in London during September 15–20, the opening session being held in the Royal Institution and the others at the Royal Society of Arts. Sir Ben Lockspeiser, secretary of the Department of Scientific and Industrial Research, was president of the symposium, and Sir Francis Meynell, director of the Cement and Concrete Association, vice-president.

More than two hundred and fifty specially invited representatives attended, including more than a hundred from overseas, twenty-six countries in all being represented. In addition to the scientific meetings, visits to laboratories and factories and social events were arranged, all of which were well attended and appreciated.

In opening the symposium, Sir Ben Lockspeiser outlined the organization of research on cement and concrete in Great Britain and directed attention to the close co-operation which is maintained between Government institutions such as the Building Research Station and the Road Research Laboratory and those supported entirely by the industry, such as the Cement and Concrete Association and the individual laboratories maintained by the larger manufacturers. The annual production of concrete and concrete products in Great Britain amounts to a value of about £180,000,000, and of this sum only about one-fifth of 1 per cent is spent on research. This leaves room for further expansion of research on cement and its derivatives. Sir Francis Meynell, in a following address, brought out in greater detail the functions of the Cement and Concrete Association. It is supported by a levy on the tonnage of cement produced, and by the end of 1951 the grand total raised in this manner amounted to nearly 1½ million pounds. Nearly £100,000 has been used for capital expenditure in the recently opened Research and Development Station of the Association at Wexham Springs. Other introductory addresses were given by Dr. R. H. Bogue, on behalf of Dr. A. A. Bates, vice-president of the United States Portland Cement Association, Prof. H. Lafuma, director of the Centre d'Études et de Recherches de l'Industrie des Liants Hydrauliques (France), and Prof. G. Wästlund, director of the Swedish Research Institute for Cement and Concrete. The final event of the opening session was a paper by P. Gooding and P. E. Halstead, on the early history of Portland cement in England.

The first of the technical sessions was devoted to studies of the constitution of Portland cement clinker. Papers were presented on tricalcium silicate (J. W. Jeffery, United Kingdom), dicalcium silicate (R. W. Nurse, United Kingdom), the interstitial phases (H. Insley, U.S.A.), the ferrite phase (G. L. Malquori and V. Cirilli, Italy), the alkali phases (T. F. Newkirk, U.S.A.), and tricalcium aluminate (F. Ordway, U.S.A.). Dr. R. H. Bogue, director of the Portland Cement Association Fellowship (U.S.A.), closed the session with a paper on "Studies on the Constitution of Portland Cement Clinker". It emerged from this series of papers that the crystal structures of the two main cementing agents, tricalcium silicate (Ca_3SiO_5) and dicalcium silicate (Ca_2SiO_4), are now known. Good approximations to the structures of tricalcium aluminate ($Ca_3Al_2O_6$) and the ferrite phase have been found. All these minerals take up minor oxides in solid solution, the composition of the ferrite phase being particularly variable, and some are further complicated by polymorphism. The information derived from crystal-structure studies has supplemented that obtained from phase-rule studies and from microscopic and X-ray examination of cement clinker. Methods of dealing with systems of four to six components were discussed by Dr. Bogue, and advances in technique, such as the high-temperature centrifuge and methods of growing single crystals for X-ray structure analysis, were described.

In the session devoted to the setting and hardening of Portland cement, papers were presented by Prof. J. D. Bernal (United Kingdom), H. H. Steinour (U.S.A.), G. L. Kalousek (U.S.A.), F. E. Jones (United Kingdom) and Prof. T. Thorvaldson (Canada). Much progress was reported in the chemistry and crystallography of the hydrated calcium silicates. The unit-cell dimensions have been determined for ten of the natural or artificial hydrated calcium silicates, which appear to form two groups, having respectively a fibrous or non-fibrous character. The fibrous group is characterized by a short fibre repeat unit of 3·65 A., which may imply the existence of silicate tetrahedra joined by hydrogen bonds, or may arise from columns of Ca—Si—O linkages. $(SiO_3OH)^{3-}$ ions have been shown to exist in afwillite. At normal temperatures two closely related calcium silicate hydrates are formed in the system $CaO—SiO_2—H_2O$, both belonging to the fibrous group and also having a layer structure, the spacing of the layer varying with the state of hydration between 9 and 14 A. This behaviour is reminiscent of certain clay minerals, and may be related to the shrinkage properties of concrete. The method of differential thermal analysis has been applied to the study of the hydrated calcium silicates, and many of the advances reported were made possible by new techniques in X-ray crystallography.

Some divergence of opinion developed regarding the constitution of set cement, the results of differential thermal analysis being interpreted as showing the existence of a single phase, whereas limited X-ray data seemed to show the independent existence in the set mass of calcium silicate and aluminate hydrates. The two methods do, however, give consistent results when applied to the study of cement cured at high temperature and pressure. Although steam treatment is commonly applied as a method of accelerating the development of strength in concrete products, it has long been known that under certain conditions the expected gain in strength may not materialize. This was shown to be related to the formation under transient conditions of a calcium silicate hydrate of the non-fibrous group.

An interesting development in the study of chemical attack on concrete is the use of radioactive sulphur as a tracer to determine the rate of diffusion of the sulphate ion in cement pastes and mortars.

The Second International Symposium (Stockholm, 1938) dealt only with Portland and high-alumina cements; but the scope of the present meeting was extended to include a session on special cements.

Papers were read on high alumina cement (T. W. Parker, United Kingdom), slag cements (F. Keil, Germany), expansive cements (Prof. H. Lafuma, France), oil-well cement (W. C. Hansen, U.S.A.) and masonry cement (C. E. Wuerpel, U.S.A.).

The constitution of high-alumina cement is complicated by the division of its fairly high iron content between the ferrous and ferric state. Theories of constitution have, in the past, been based mostly on the results of petrographic examination, since phase-rule studies have not been of great value. At the recent meeting, it was shown that if MgO is used as a 'model substance' for FeO, phase data in the system $CaO—MgO—Al_2O_3—SiO_2$ can be applied to this problem. Thus the blue pleochroic mineral described by Sundius and others has been shown to have the composition $6CaO.4Al_2O_3.FeO.SiO_2$. In identifying the calcium ferrites and alumino-ferrites, measurement of reflecting power of the microscopic grains has been found useful.

The principal constituent of slag cements is a glass formed by the rapid quenching in water of molten blast-furnace slag. Such glasses vary widely in their reactivity as cements, and many attempts have been made to relate this activity to chemical composition. Work on artificial glasses containing only a few components was described, and also preliminary attempts to elucidate their structure by chemical means. A number of useful empirical tests for the quality of granulated slag were discussed.

The deliberate production of a controlled expansion is one method of compensating the shrinkage which accompanies the drying of normal cements. For certain applications, such as patching, underpinning and post-stressing, a larger expansion can be produced if necessary. The method employed is to bring about the formation of calcium sulphoaluminate in the set mass; this reaction is the principal cause of the disintegration of concrete in sulphatic waters; but in the present application the expansion is kept under careful control.

Oil-well cements are required to set at considerable depths below the ground under conditions of high temperature and pressure; but the setting time must be long enough for the cement slurry to be pumped down to the required depth. In the paper presented to the symposium, the various organic substances used for regulating the set were classified and it was suggested that HO—C—H groups are particularly effective in retarding the action of water on cement.

For use in masonry jointing or as a rendering, ordinary cement requires to be diluted with lime, limestone or fine sand, to reduce the formation of shrinkage cracks, and to improve the working properties of the mortar. Air-entraining agents may also be added. A modern development is to market the accurately proportioned mixture as masonry cement. Various problems arise in testing such cements, involving a knowledge of the rheological properties of stiff and semi-plastic pastes.

In the final session, the applications of research in cement manufacture were discussed in papers by H. Gygi (Switzerland) and T. Heilmann (Denmark), while A. R. Collins (United Kingdom) and M. A. Swayze (U.S.A.) presented papers on problems in the utilization of cement.

The closing address was given by Dr. F. M. Lea, director of building research, Department of Scientific and Industrial Research, who surveyed the work of the symposium and suggested lines along which future research might be developed. He referred to the great advances made since the last symposium in the application of X-ray analysis to cement research. One of the most baffling problems in this field has been the determination of the state of the water held in set cement. By means of X-ray structure analysis, it has been shown that some of the water chemically combined can be present as hydroxyl groups and some as molecular water. There must be a relationship between the expanding lattice of the hydrated silicates and shrinkage and moisture movement of concrete. The picture that is emerging as a result of this work and of the physical studies made on cement pastes using the adsorption isotherm technique is much more satisfactory than the earlier theories based solely on capillary phenomena and the Kelvin equation.

The combination of electron microscopy with electron diffraction is proving in this, as in other fields, a powerful research tool, and the use of ultrasonic energy for dispersing material and hastening chemical reaction is of great interest and may possibly have practical applications.

As a result of the research already done, the civil engineer is now presented with a choice of cements eminently suited to particular applications. As old problems are solved, however, new ones arise, and there is a constant need for a background of research in an industry so important as that of cement manufacture.

The proceedings of the Symposium, including the written and spoken discussion, will be published. Inquiries should be made to the Organizing Secretary, P. Gooding, Cement and Concrete Association, 52 Grosvenor Gardens, London, S.W.1. R. W. Nurse

INTERNATIONAL ASTRONOMICAL UNION

The eighth General Assembly of the International Astronomical Union was held in Rome during September 3–13, on the invitation of the Consiglio Nazionale delle Ricerche. The inaugural ceremony took place in the Hall of Orazi and Curiazi in the Campidoglio, when the Mayor of Rome, the president of the Consiglio Nazionale delle Ricerche, Prof. Gustavo Colonnetti, and the Minister of Education welcomed the Congress, and the president of the Union, Prof. Bertil Lindblad, replied. More than four hundred delegates from thirty-six countries were present. After the opening session of the General Assembly, the Union resolved itself into a number of small groups: thirty-nine commissions of the Union covering all branches of astronomy met either separately for their special work or jointly for discussions of common interest. In addition, two Joint Commissions of the International Council of Scientific Unions—Spectroscopy and Solar and Terrestrial Relationships—took the opportunity of the gathering to hold meetings in Rome at the same time. Further, three symposia were organized, each for a full day. These were on "Stellar Evolution", on "The Astrometry of Faint Stars" and on "Instruments".

The following took part in the first symposium: V. A. Ambartsumian, O. Struve, B. Lindblad, W. Baade, E. Kukarkin, L. Gratton, F. Hoyle, A. Severny, G. A. Shajn, C. Fehrenbach, V. G. Fessenkov, E. Schatzmann, G. P. Kuiper, M. Schwarzschild,

T. Gold, H. Alfvén, R. A. Lyttleton and D. Martynov. The papers of Shajn and Fessenkov were read for them in their absence. The discussion, as may be judged by the names of those taking part, was lively and at times argument was intense; naturally, no decisions were reached, but a most stimulating meeting was held. The importance of Baade's two stellar populations came prominently into view. The chairmen were H. Bondi and O. Struve.

In the second symposium, which was concerned with the positions and motions of faint stars, the chairmen were J. Jackson and A. A. Nemiro. The subject-matter was less controversial, but perhaps more fundamental, than in the case of the first symposium, and the speakers or contributors of papers included M. S. Zverev, A. Blaauw, A. N. Deutsch, A. Kopff, J. Larink, J. H. Oort, E. W. Rybka, S. Vasilevskis, A. N. Vysotsky, D. Brouwer and R. H. Stoy. In the third symposium E. H. Linfoot, A. Couder, A. Lallemand and I. S. Bowen presented papers on various telescopes and auxiliary apparatus.

Several of the meetings of groups of commissions must be mentioned. The Commissions on Ephemerides, Astronomical Constants, Celestial Mechanics, the Moon, Minor Planets, Comets and Satellites held a joint meeting at which the recommendations were adopted which had been made to the Union by the Paris conference, held in 1950, on the fundamental constants of astronomy. A whole day was devoted to a discussion of the spectra of variable stars at a joint meeting of the Commissions on Variable Stars and Stellar Spectra—more than thirty papers were presented. A joint meeting of the Commissions on Radio-astronomy, Interstellar Matter and Stellar Statistics produced, perhaps, the high lights of the meeting—Oort's account of the possibilities of exploring the dark arms in the Milky Way spiral structure through the use of the 21-cm. line due to atomic hydrogen, and Baade's account of the discovery of rings and wisps of nebulosity surrounding the positions of radio stars located by the observers at Cambridge and Manchester.

During the meeting, visits were paid to the Observatories at Castel Gandolfo and Monte Mario. On the former occasion, His Holiness Pope Pius XII addressed the Union on the progress achieved by astronomy and astrophysics in the past fifty years, and afterwards met individual members and spoke with them on their work.

At the closing session of the Union, a number of recommendations from the Commissions were adopted. Among others, mention must be made of the following: an appeal for observations of the transit of Mercury across the sun's disk in November 1953; an amendment of Brown's Tables of the Moon by removing the empirical term and applying a correction to the mean longitude; an appeal for further work in the southern hemisphere in the field of fundamental meridian astronomy, catalogues of faint stars, and an extension of the Lick sky survey; another appeal for systematic measurements of the general magnetic field of the sun; a suggestion for a joint commission with the Unions of Geodesy and Geophysics and of Radio-Sciences to arrange, possibly in connexion with a proposed International Polar (or Geophysical) Year in 1957–58, for a third set of determinations of an accurate network of world longitude; and a general adoption of the three-letter nomenclature for constellations. Financial recommendations approved by the Finance Committee and adopted included a number of regular items and, in addition, a grant for the Astronomical News Letters which summarize work published exclusively in Russian; a grant to Meudon Observatory to put into operation the photo-electric photometer of the late Bernard Lyot, for measuring the intensity of solar coronal spectral lines; a grant to P. Swings for the publication of a photographic atlas of typical spectra of comets; and a grant to facilitate the exchange of astronomers between countries.

Invitations for the next General Assembly of the Union had been received from Eire and Poland. A vote by countries was in favour of accepting the invitation from the Dublin Institute for Advanced Studies, and the next General Assembly will be held in Dublin in 1955. The Bureau for the next three years was elected as follows: *President*, O. Struve (U.S.A.); *Vice-Presidents*, V. A. Ambartsumian (U.S.S.R.), A. Couder (France), E. Rybka (Poland), P. Swings (Belgium) and R. v. d. R. Woolley (Australia); *General Secretary*, P. Th. Oosterhoff (Netherlands). The retiring president and secretary, B. Lindblad (Sweden) and B. Strömgren (Denmark and U.S.A.), are *ex officio* members.

The above account indicates clearly the crowded nature of the activities of a very successful meeting. Although the symposia and group meetings were most successful and added greatly to the interest of the meeting, there were signs in several quarters of a tendency to crowd out the administrative organizational work of the separate commissions. This tendency must be watched carefully, as such work is the real fundamental basis of the Union's continued success. No account of the meeting could be regarded as complete without reference to the most generous hospitality received in Rome from the Mayor of Rome and from the Consiglio Nazionale delle Ricerche, who placed every facility at the disposal of the Union.

F. J. M. Stratton

THE BRITISH PHARMACEUTICAL CONFERENCE, 1952

THE eighty-ninth British Pharmaceutical Conference was opened at Nottingham on September 1 and the attendance exceeded five hundred. The chairman, Mr. H. B. Mackie, approached the subject of pharmaceutical education with originality when he entitled his address: "An Education for a Pharmacist". He pictured the pharmacist as a professional man, comprehending the scientific basis of drugs and drug action, able to evaluate critically the products he handles and competent to advise physicians concerning drugs and their uses.

The early education of the future pharmacist, Mr. Mackie said, should be as broadly based as possible, designed to discover aptitudes and latent potentialities and should seldom degenerate into formalized, didactic instruction. Latin might be restored to its original place, for young people lacking Latin have a hard road to travel to be completely literate. The test of a successful early education is not the amount of knowledge that a pupil takes away from school but his appetite to know and capacity to learn.

Of professional studies, there is little to be said concerning pharmaceutical chemistry—now fairly clearly delimited. Pharmacology and pharmacognosy used in the broadest sense mean the same thing,

'knowledge about drugs', both terms having now assumed an acquired meaning. Pharmacology is important, since it provides a link in the chain of knowledge between pharmacy and medicine. A modern education for a pharmacist must strengthen the link. The changing and enlarging field of therapeutics confronting the physician makes it imperative that he have assistance in finding his way through the labyrinth of complex, controversial materials. The pharmacist should be so trained as to be a source of authentic, unprejudiced information and able to inform the public as to the merits of new therapeutic agents. Probably all would agree that any course of applied science should provide information, useful to the student in solving problems of to-day and to-morrow, while teaching principles in preference to communicating isolated facts. Facts are quickly forgotten and are found in hand-books. Understanding is more difficult to acquire, but once acquired becomes an integral part of the student's mind.

The use of drugs has a very long history; but pharmacognosy as a science dates from the beginning of the nineteenth century. Despite increased chemical knowledge about natural products, there has been little influence upon the teaching of pharmacognosy. The subject could be usefully integrated with pharmacology. Although doubts have been expressed about the necessity of pharmacognosy for the practising pharmacist, it is pharmacy's specific and peculiar contribution to the cause of science. It behoves us to esteem it well.

Galenical pharmacy enables us, Mr. Mackie pointed out, to present trains of thought and methods of scientific manipulation, which as yet lie outside the domain of equations and formulæ. Terms such as 'tincture' and 'syrup' apply to a complex association of materials derived from vegetable structures, and processes involved in their preparation date to the beginning of man's historical record. Galenical pharmacy is and always has been based on colloidal complications. As the normal structure and juices of most or all plants are colloidal, the study of pharmacy as applied to natural substances is that of colloidal research and colloidal manipulation. Accepting that non-crystalline substances compose the major part of plant tissues, it becomes the pharmacist's duty to disentangle these complicated structures, providing a product not having undergone fundamental re-arrangement.

There is no 'alkahest', no universal solvent, as was dreamt of by Paracelsus. The most promising neutral liquids for extracting natural colloidal groups are listed by Uri Lloyd. These solvents may virtually exhaust most plant contents. A saturate is not an ultimate, but may be complex and require sub-division, giving more closely related substances. Such manipulation individualizes colloidal plant structures to a degree of pharmaceutical satisfaction, though not absolute chemical perfection. The use of a neutral liquid as an excluder is exemplified in ox-bile and the piecemeal separation of certain opium alkaloids; then reassembly produces well-known injectable products. There appears practically no limit to the production of medicaments which evoke the precise therapeutic response desired, plus the synergistic effect that frequently accompanies this, while free from inhibiting or damaging reaction. Colloidal scales possessing all the properties of the original drug may be produced. A new field has been introduced by the discovery of the alkaloidal affinities of hydrous aluminium silicate, though it is not yet certain if it will enable us to obtain plant substances in a purified and active form.

In the therapeutic application of a substance its condition is most important; for example, the superiority of finely divided mercury. The alkaloidal strength of a nux vomica galenical may be increased by adding strychnine, but has the quality improved?

The attempt to achieve standardization by a single dominating constituent is but a struggle towards a pharmaceutical standard of excellence in which therapeutic quality should be the ideal and which for the moment should be stressed in our scheme of training. It is fanciful to believe that there is some analogy between elaborately processed 'foods' and the substitution of synthetic chemicals in medicine for naturally occurring substances. The future pharmacist will not be chiefly a purveyor of tablets, and it may be true to-day as when written in medieval times that "Contra malum mortis non est medicamen in hortis".

Mr. Mackie completed his address by reminding his fellow-teachers that some of the most important men in history have been teachers. Many of the biggest advances in civilization have been the chief work, not of politicians or inventors, not even of artists, but of teachers. We have Ruskin's assurance that pay alone never made a better soldier or a teacher. We are servants of reality; our responsibility is to the young and through them to the future.

Among the scientific papers read and discussed at the Conference, there were several which reflected the tone of the chairman's address. Factors influencing the separation of hyoscine and hyoscyamine by elution development of a chromatographic column had been studied and a simple assay described. Another paper was concerned with the detection of common medicinal alkaloids by the chromatographic method. Much work was reported on the assay of *Digitalis* glycosides. One group of workers had investigated the assay of mixed chloroform-soluble glycosides, while others dealt with the colorimetric estimation of digitoxin and compared the method with biological assay.

Assay methods were, in fact, a prominent feature of the papers read. The polarographic estimation of riboflavine was found to be more reliable than the simple colorimetric method and more rapid than other methods used. The available methods for the determination of ascaridole were reviewed and a possible polarographic method examined. The use of emission spectrography in pharmaceutical analysis was reported upon, and the methods outlined showed a considerable saving of time over normal chemical methods. A useful contribution was made to the evaluation of surface-active agents, based on the measurement of stability of the emulsions yielded. Two workers indicated that a small lymphocyte count is a more accurate method of pyrogen assay than temperature measurement.

Studies on tuberculostatic compounds reflected the vitality of pharmaceutical research. Papers dealt with methods of assaying *iso*-nicotinic acid hydrazide and the more general pharmacology of *p*-amino-salicylic acid.

Antibiotics featured prominently in the discussions of the Conference, and it was reported in one paper that the pharmacodynamical groups present in the chloramphenol series fall into two categories, namely, specific and relatively non-specific. Recent developments in the pharmacy of antibiotics were

dealt with in a symposium session which covered aspects of general and hospital practice. A contribution to the latter session gave a more widespread picture of the subject and illustrated the remarkable expansion of knowledge achieved since the general discussion on penicillin at the 1946 Conference.

Other developments in the field of pharmaceutics included the successful use of infra-red radiation for drying a wide variety of products. Bacterial survival in systems of low moisture content was further reported upon, namely, the effects of increasing moisture content on heat resistance, viability and growth of *B. subtilis* spores. The determination of quality of surgical dressings had been further investigated, on this occasion being concerned with their water retention. S. B. CHALLEN

FISHERIES RESEARCH UNIT OF THE UNIVERSITY OF HONG KONG

THE need for a Fisheries Research Station in Hong Kong has long been realized; but the various plans for one which have been put forward from time to time have for various reasons been found impracticable. However, a satisfactory scheme was recently worked out by the University of Hong Kong in conjunction with the local Government, and a Fisheries Research Unit commenced work recently in the University's Department of Biology. The University has provided approximately a thousand square feet of laboratory accommodation for the Unit, and the director is reader in marine biology on the University's staff. The association between the Unit and the Department of Biology resembles that existing between various agricultural research units which are attached to a number of universities in Great Britain, for example, the Bureau of Animal Population and the Department of Zoology in the University of Oxford.

The director, Mr. Alan Tubb, who was formerly director of fisheries in the Colony of North Borneo, will take up his duties in April next year; meanwhile, Prof. D. Barker, professor of zoology and head of the Department of Biology in the University, is acting director. The director will be assisted by a chief scientific officer and three assistant scientific officers; so far, two assistants have been engaged. The rest of the staff establishment consists of a laboratory steward and attendants, and the skipper and crew of a research vessel at present under construction. The laboratory accommodation includes marine aquaria supplied with running sea-water, and a laboratory suitable for chemical and biological work. There is a considerable library of books and journals on fisheries research, and the Unit has access to the University's scientific library. Provision has been made for equipping the Unit's laboratory with the appropriate research facilities and apparatus. The cost of establishing the Unit is being met out of Colonial Development and Welfare funds, while recurrent expenditure is being met by the local Government; in each case the government contribution is by means of block grants made over to the University for its administration.

The research vessel is a 66-ft. diesel-powered otter trawler. The keel is now being laid and she should be in commission by the summer of 1953. She will be equipped with a laboratory, echo sounder, radio telephone and wireless telegraphy, bottom sampler, bathythermograph, and various other apparatus required for oceanographical work. The vessel will work in waters up to a hundred miles distant from Hong Kong, and the longest trips will be of from seven to ten days duration.

From the point of view of marine research, Hong Kong is very favourably situated, being at the extreme south-east corner of Asia almost at the junction of temperate and tropical waters and within easy reach of ocean and estuarine fishing grounds. The Fisheries Research Unit is the most easterly of a chain of Commonwealth fisheries research stations, and its researches and findings will not only be correlated with those of Ceylon, Malaya and India, but will also be of value to the Dominions of Canada and Australia and to other countries which border on the Pacific Ocean or the China Sea. It is expected that the research carried out by the Unit will lead to improvements of catch in the immediate neighbourhood of Hong Kong and will contribute substantially to general fisheries research in the Indo-Pacific region. Under the auspices of the Indo-Pacific Fisheries Council, the Unit will pool its results and collaborate with similar stations in the Philippines, North Borneo, French Indo-China and Malaya in research projects relating to the China Sea. Among other problems the Unit will aim at undertaking the following research: survey the existing fishing grounds around Hong Kong, map them, and determine their species population and production; survey the sea-bottom, salinity and plankton in local waters; study ocean currents and the effect of such currents and prevailing winds on the movement of fish, with the possibility of discovering new fishing grounds; determine the influence of the Pearl River on the fishing around Hong Kong; study factors influencing the yield of catch in the local fishing grounds with the view of forecasting production; investigate the movement and feeding habits of fish, and, wherever possible, locate spawning grounds, etc., with the aim of trying to initiate control; make studies in relation to the extension and improvement of salt, brackish and freshwater fish-pond culture.

UNESCO INSTITUTE FOR EDUCATION, HAMBURG

UNESCO has recently sponsored an unusually interesting experiment in West Germany, on a smaller scale than those activities with which Unesco is popularly associated. The experiment consists of the establishment of three Institutes, each of which began work during 1952. One is for Social Sciences, at Cologne; one for Youth, at Munich; and one for Education, in Hamburg.

These Institutes are remarkable in two respects. First, each has an international governing board consisting of seven non-German and six German members, the funds of which are derived not from the general Unesco budget but in response to an appeal by the Director-General to individual nations. Secondly, the Federal Republic of Germany has agreed to and encouraged the establishment within its own territory of institutes over which it has not a controlling majority, but which it is prepared to finance up to a minimum of twenty per cent of their budgets. Perhaps equally noteworthy is the fact that among those nations which have contributed small

amounts to the Institutes are to be found India and the Philippines; and the United Kingdom is not to be found among the principal contributors, France, Germany and the United States.

With regard to the Institute of Education at Hamburg, the objects are briefly: (1) to foster international study of educational problems (particularly to enable German educators to meet educators from other countries); (2) to carry out research into educational aims and methods; and (3) to participate in action undertaken by Unesco in its campaign for the maintenance of peace and in its programme of education for international understanding.

The Governing Board determines policy from time to time and is responsible for framing an annual budget. The Board consists of representatives of Germany (six), Canada, Denmark, France, Italy, Switzerland, the United Kingdom and the United States of America (one each), together with a representative of the Director-General of Unesco. From among the members of the Board, a Standing Committee of five has been appointed, again with a marginal majority of non-German members.

The Governing Board decided that the first item on the programme of the Institute should be a seminar on "Adult Education as a Means of Developing and Strengthening Social and Political Responsibility". This seminar opened on September 8 and continued for one week. Thirty-five participants from fourteen countries (including three from England) were the guests of the Institute. The physical atmosphere of the Institute provided assurance of a favourable meeting place. The introductory remarks of the director of the Institute, Prof. Walther Merck, and of the chairman of the Governing Board, Prof. J. Novrup (but in his capacity as an ordinary participant), led the seminar along the road of realistic discussion of some of the problems of adult education. The five groups into which the members divided (two English-speaking, two German and one French—but with a wide distribution of nationalities) discussed aspects of political responsibility, social responsibility and special methods in adult education. It was generally agreed that nothing really new had emerged, or indeed could be expected to emerge, but that for the first time the issue of political responsibility had been squarely faced. A full report will be published later in English, French and German.

Anyone attending the Institute's social evening, with cold supper and wines served in the Institute House, and joining the subsequent gathering in the library, would have found it difficult to believe that such a diversity of nations could behave and indeed think and act with such bon-accord, despite difficulties of language.

The Institute received many valuable suggestions for further action, and these are now being examined to find out how far they can be implemented, and whether some of them can be pursued in co-operation with the Youth and Social Sciences Institutes.

The second major item on the Institute's programme will be a seminar on "The Factors of Pre-School Education which influence the Development of a Personality creatively able to participate in a World Community". The date of this seminar has not been finally decided; but it will be held in the first or second week of January 1953. In the light of experience of these two seminars and the activities which they inspire, the Governing Board will, when it meets this month, plan a programme of work for 1952–53.

HUGH MILLER, 1802–56

COMMEMORATION AT CROMARTY

By Sir EDWARD BAILEY, F.R.S.

COMPARATIVELY few now remember the stir attending the centenary of Hugh Miller's birthday, celebrated in 1902. Some 1,500 pilgrims from far and near assembled under the great column and statue which already commemorated Cromarty's most distinguished son. Sir Archibald Geikie was that day chief among a dozen speakers, including Principal Rainy, of the United Free Church, Prof. Clarke, of Albany, U.S.A., Dr. John Horne, of the Geological Survey, and Sir James Grant, president of the Royal Society of Canada. Geikie gave of his best in love and gratitude to the memory of the man who had introduced him, and many others of his generation, to the wonderland of geology. In doing so he remarked, a little pathetically, that he found himself the last survivor among geologists who could lay claim to intimate friendship with the erstwhile stonemason. Fortunately, his beautiful address is fully reported in *Nature* (66, 426, 1902), while the ceremony as a whole is detailed in a valuable booklet entitled "The Centenary of Hugh Miller" (Glasgow, 1902).

Carnegie was among those present at the centenary gathering, and shortly afterwards he generously presented Cromarty with a Hugh Miller Library and Institute—a further fitting memorial. Then, in 1938, the National Trust of Scotland, which meanwhile had come into existence, took over from the Town Council the cottage where Hugh Miller had been born, already functioning as a shrine. The occasion was marked in *Nature* (142, 696; 1938) by an appreciation of Hugh Miller's work.

On October 14 of the present year, on the invitation of the Earl of Wemyss, chairman of the National Trust, a small gathering of about fifty met in the paved courtyard of Hugh Miller's cottage to celebrate the hundred and fiftieth anniversary of the great man's birth. After the chairman had explained the Trust's need for additional memberships and subscriptions to carry on its vitally important tasks of conservation, he asked Sir John Erskine, general manager of the Commercial Bank of Scotland, to recall a significant episode in Hugh Miller's career. Sir John reminded us how, after fifteen years as stone-mason, Hugh Miller, in 1834, accepted an offer of the accountantship of the Commercial Bank's agency at Cromarty; and how he held this post until, at the beginning of 1840, he agreed to edit *The Witness*, a militant newspaper launched to represent the views of an important section of the Presbyterian Church of Scotland. Sir John cited contemporary evidence of Hugh Miller's speedy adaptation of himself to a totally new style of endeavour, which brought him not only increase of money—very welcome to a man in love—but also increase of opportunity for study and writing.

Subsequent speakers were the Rev. J. H. Baxter (University of St. Andrews) and the Rev. John Macleod (University of Aberdeen). Both stressed the intensely religious outlook of Hugh Miller and his extraordinary (and also successful) introduction of geological discovery into the pages of *The Witness* from the very start of his editorship.

The anniversary meeting was blessed throughout with perfect weather. An additional delightful feature

was the presence of two great-grandchildren of Hugh Miller (Brigadier A. A. Middleton and his sister), along with two great-great-grandchildren and one great-great-great-grandchild—the latter, Louisa Gordon, aged six. Brigadier Middleton's father, Sir Thomas Middleton—a mere grandson—had been one of the speakers at the centenary fifty years ago; now Louisa Gordon was invited by Lord Wemyss to head the roll of attendance with her signature.

COBALT IN THE NUTRITION OF RUMINANTS*

Response of Cobalt-deficient Sheep to Massive Doses of Vitamin B_{12}

WE now have unequivocal evidence that the deficiency-syndrome suffered by sheep grazed on cobalt-deficient pasture is, in fact, the result of vitamin B_{12} deficiency.

Experiments[1] conducted here in 1943–44, which showed clearly that, to be effective for the prevention or for the cure of the malady, cobalt must be administered *per os*, focused attention on the nutritional importance of cobalt for the development of some at least of the mixed population of organisms which normally inhabit the rumen, and indicated that cobalt might exert its activity, primarily, by favouring the proliferation of organisms responsible for the production of accessory food factors essential for the animal.

The fact that a profound macrocytic anæmia is a feature of the terminal stages of the cobalt-deficiency syndrome led us, early in our studies, to examine the effects of dosing with liver extracts, and much later, when small supplies of vitamin B_{12} became available, the effects of administration of the pure, cobalt-containing vitamin. The doses used in these earlier experiments were of similar order to those employed for depot therapy in the treatment of Addisonian pernicious anæmia (that is, 15–30 U.S.P. injectable units a week: the U.S.P. unit of liver extract contains approximately 1 μgm. vitamin B_{12}). In a series of experiments which would have enabled small effects to be measured, no significant change in the progress of the syndrome was observed to supervene on treatment with these amounts of liver extract or of vitamin B_{12}, irrespective of whether the dose was administered *per os* or parenterally.

More recently, Becker and Smith[2], who had identical experience with similar doses, reported that injection of much larger quantities of liver extract (15 U.S.P. units a day) into cobalt-deficient lambs elicited responses of the same order of magnitude as those brought about by administering adequate cobalt *per os*. These authors mentioned in an addendum to their paper that "larger amounts of Vitamin B_{12} do result in a positive response in cobalt-deficient lambs", and, later, supporting evidence was published[3].

The first report led us to study the effectiveness of parenteral injection of relatively large amounts of vitamin B_{12} (equivalent to 300 μgm. vitamin B_{12} a week) into experimental sheep which had developed cobalt-deficiency while grazing on cobalt-deficient pastures, and which had failed to benefit from intramuscular injection of the equivalent of 15 μgm. vitamin B_{12} a week.

* See also p. 807.

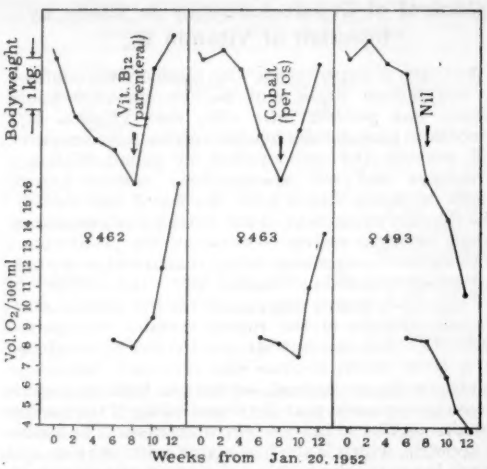

Fig. 1. Effect of treatment with cobalt and with vitamin B_{12} on the body-weight and oxygen-carrying capacity of the blood of ewes in an advanced stage of cobalt deficiency

The responses reported in Fig. 1 are typical. This group of three young merino ewes was one of a series drawn from an experimental flock that had grazed for approximately a year on frankly cobalt-deficient pastures, and which had not previously been treated with cobalt. All were in an advanced stage of cobalt-deficiency. The first criterion adopted for the selection of the animals into groups was the degree of anæmia—the oxygen-carrying capacity of the bloods of the animals in this particular group was close to 8 vol. oxygen per 100 ml. at the period when they were selected for treatment. The animals were of similar body-weight (*c.* 20 kgm.). At the point indicated, No. 462 was treated with 300 μgm. vitamin B_{12} a week, injected into the gluteal muscles in doses of 100 μgm. thrice weekly; No. 463 was treated with the equivalent of 7 mgm. cobalt a week administered *per os* thrice weekly at similar intervals; No. 493 was untreated and served as a control. The effects of the treatment are obvious. The slight lag in the response of No. 463 was typical of many but not all of the animals which received cobalt.

These observations, together with others from more intensive studies[4] of cobalt-deficient sheep confined in metabolism cages under laboratory conditions, leave little doubt that the syndrome of cobalt-deficiency in ruminants is the result of a shortage of vitamin B_{12}, and point to the probability that ruminants require much more of this vitamin than do other animals. Normally, when the cobalt concentration of the ingesta imposes no limit to the proliferation of organisms responsible for the synthesis of vitamin B_{12} in the rumen, the amount produced there is large (see footnote 5 for references).

A full account of these experiments will be published elsewhere.

HEDLEY R. MARSTON
H. JOHN LEE

June 3.

[1] Marston, H. R., and Lee, H. J., *Nature*, **164**, 529 (1949).
[2] Becker, D. E., and Smith, S. E., *J. Nutrition*, **43**, 87 (1951).
[3] Smith, S. E., Koch, B. A., and Turk, K. L., *J. Nutrition*, **44**, 455 (1951).
[4] Marston, H. R., and Smith, R. M. (see accompanying communication).
[5] Marston, H. R., *Physiol. Rev.*, **32**, 66 (1952).

Control of Cobalt-deficiency in Sheep by Injection of Vitamin B_{12}

A series of experiments with merino ewes confined in metabolism cages and fed on cobalt-deficient rations has proved, *inter alia*, that vitamin B_{12}, introduced parenterally in relatively massive amounts, will prevent the development of cobalt-deficiency symptoms and will spectacularly restore normal health to sheep which have developed the malady. The findings imply that, in the nutrition of ruminants, cobalt functions merely to stimulate the proliferation of those micro-organisms in the rumen which produce the cobalt-containing vitamin B_{12}; the activity of the micro-organisms responsible for the fermentation of carbohydrate in the rumen remains unimpaired when the cobalt concentration of the fodder is reduced to a level which induces the profound deficiency-syndrome in the animal, as critical balance experiments have proved that the digestibility of the rations remains unaltered in these circumstances. The failure of appetite, which is the first symptom to appear, and which is progressive, is thus the result of a metabolic defect and not of a reduced capacity of the animal to digest and absorb its foodstuffs.

In these experiments the ration offered each day was comprised of 1 kgm. of cobalt-deficient wheat hay and 50 gm. of washed wheat-gluten: it provided 4,100 kcal. (gross) of combustible energy, of which between 40 and 42 per cent was voided in the fæces; it provided the protein equivalent of 18·3 gm. nitrogen, of which 5·9 gm. nitrogen appeared in the fæces; and, as the chaff contained 0·025 μgm. cobalt per gm. and the gluten rather less, it provided < 25 μgm. cobalt a day, which is less than one-third of the minimum requirement estimated from experiments with sheep on cobalt-deficient pastures[1]. When supplemented with cobalt, these rations maintain mature sheep (40–45 kgm.) in positive energy balance and in excellent health.

After being taken from normal pastures and confined to these rations, all the ten mature ewes which comprised the experimental animals referred to here increased gradually in weight for a period which, in some, extended for several months before their tissues became depleted to a degree which no longer allowed the animal to deal effectively with the whole of its rations; appetite then began to fail and eventually the syndrome progressed steadily in all the animals that were untreated.

The performance of the three ewes recorded in Fig. 2 is typical of the individuals which were the first to develop deficiency symptoms. The responses of No. 5009 to a supplement of 1 mgm. cobalt a day, *per os*, and of No. 7019 to 50 μgm. of vitamin B_{12} per day, injected intramuscularly, are virtually identical, and leave little doubt that the cobalt-deficiency syndrome is the consequence of a metabolic defect resulting from a deficiency of vitamin B_{12}.

Of another group of three ewes, which after thirty-five weeks under identical conditions had not become depleted to the stage at which appetite begins to fail, one was treated with 1 mgm. cobalt a day *per os*, one with intramuscular injections of 50 μgm. vitamin B_{12} a day, and one was left untreated. The overall digestibility of the rations, and the vitamin B_{12} activity of the excreta, were determined in two 14-day periods, one immediately prior to treatment and one which began 14 days subsequent to the day on which treatment was started. Cobalt administered *per os* to No. 5012 increased the vitamin B_{12} activity in its fæces from 490 to 3,700 μgm. vitamin B_{12} (equiv.) per day as assessed by the *Escherichia coli* assay and from 245 to 720 μgm. vitamin B_{12} (equiv.) a day by the *Lactobacillus leichmannii* assay; whereas vitamin B_{12} administered to No. 9072 effected no significant change, the mean activities of the fæces passed in the pre- and post-treatment periods being 590 and 520 μgm. vitamin B_{12} (equiv.) a day (*E. coli*) and 250 and 280 μgm. vitamin B_{12} (equiv.) a day (*L. leichmannii*) respectively. The appetite of the untreated ewe, No. 9090, began to fail during the second collection period; at that juncture the mean vitamin B_{12} activity of its fæces was 400 and 270 μgm. vitamin B_{12} (equiv.) a day, as estimated by the respective methods.

As the treated animals in this group consumed the whole of their rations during both periods, the overall digestibility of cellulose and the quota of the combustible energy in the fodder which was excreted in the fæces could be estimated precisely. Neither cobalt (*per os*) nor vitamin B_{12} (parenteral) effected any change in the overall digestibility of the fodder, although a considerable alteration in the nature of the microbial population of the intestinal tract of the animal which received a supplement of cobalt is implied by the increase in the vitamin B_{12}-activity of its fæces. Similar balances were conducted on the other three animals mentioned above. The vitamin B_{12} activity of their excreta is discussed by our colleagues,

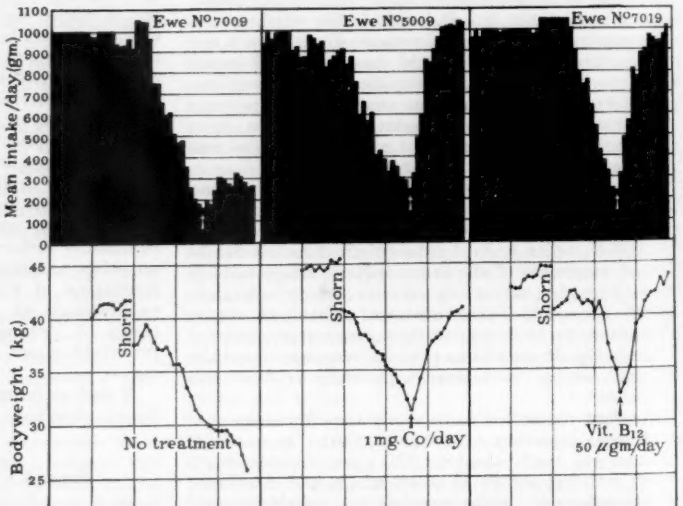

Fig. 2. Effect of treatment with cobalt or with vitamin B_{12} on the progressive failure of appetite and consequent loss of weight of sheep confined on rations short of cobalt

Dawbarn *et al.*[2], who were responsible also for the microbiological assays reported here.

In all, these findings are in complete accord with the hypothesis that the syndrome of cobalt deficiency in the ruminant is the result of a metabolic defect arising from a profound deficiency of vitamin B_{12}. Ruminants apparently require much more vitamin B_{12} than other animals, but the reason for this is not yet clear. There is no evidence that cobalt performs any physiological function in the tissues of animals other than as a constituent of vitamin B_{12}. The details of these experiments will be published elsewhere.

HEDLEY R. MARSTON
RICHARD M. SMITH

June 3.

[1] Marston, H. R., and Lee, H. J., cf. Marston, H. R., *Physiol. Rev.*, 32, 66 (1952).
[2] Dawbarn, M. C., Hine, D. C., and Hughes, P. (see following communication).

Influence of Cobalt on the Production of Factors possessing Vitamin B_{12}-like Activity in the Fæces of Sheep

WE have estimated the vitamin B_{12} and similar factors in the urine and fæces of a number of sheep which were confined in metabolism cages and fed on cobalt-deficient rations, and which were employed by Marston and Smith[1] for the experiments referred to in the preceding communication.

During the collection periods referred to here, an aliquot of the urine passed each day was treated with cyanide, adjusted to *p*H 6·8 and stored at − 20° C. until composite samples were made up immediately before the assays were conducted. Aliquots of the fæces were taken each day and stored at − 20° C. in sealed containers until required.

The active material in the urine was measured by its capacity to promote the growth and lactic acid production of *Lactobacillus leichmannii* 313 under strictly controlled conditions. Extracts of the fæces were analysed by this method and also by the plate method of Harrison *et al.*[2], in which the test organism is a mutant of *Escherichia coli*. The results are shown in Tables 1 and 2. All animals had been on the deficient rations for 35 weeks before the treatments were begun. Period *A* was the 14 days immediately prior to treatment; period *B* was the 14 days beginning a fortnight after treatment was started. The first three animals were in an advanced stage of the cobalt-deficiency syndrome and their food intake in period *A* was less than 250 gm. per day; in period *B* animals No. 5009 (cobalt) and No. 7019 (vitamin B_{12}) consumed more than double this amount, whereas the intake of No. 7009 (untreated) remained practically unchanged. The second three animals had not become sufficiently depleted for their appetites to fail and consumed the whole of their rations, 1,050 gm. a day, in period *A*. The intakes of No. 5012 (cobalt) and No. 9072 (vitamin B_{12}) were unchanged in period *B*, but No. 9090 (untreated) began to lose its appetite[1].

Table 1. Effects of Administration of Cobalt and of Vitamin B_{12} on the 24-hr. Excretion of Vitamin B_{12}-like Substances in the Urine and Fæces of Sheep on Cobalt-deficient Rations

Sheep No.	"Vitamin B_{12}" in urine (μgm.) (*L. leichmannii*)		"Vitamin B_{12}" in fæces (μgm.) (*E. coli*)		"Vitamin B_{12}" in fæces (μgm.) (*L. leichmannii*)		Treatment in period *B*
	Period *A*	Period *B*	Period *A*	Period *B*	Period *A*	Period *B*	
7009	0·18	0·26	—	135	—	95	Nil
5009	0·15	2·9	110	2,560	50	320	1 mgm. cobalt a day (*per os*)
7019	0·83	12·7	100	310	60	115	50 μgm. vitamin B_{12} a day (parenteral)
9090	0·78	0·85	—	400	—	270	Nil
5012	0·23	3·1	490	3,700	245	720	1 mgm. cobalt a day (*per os*)
9072	1·03	6·1	590	520	250	280	50 μgm. vitamin B_{12} a day (parenteral)

Ford and Porter[3] have reported that several "B_{12}-like factors" occur in the fæces of calves, and that these differ in their capacity to promote the growth of the two micro-organisms *E. coli* and *L. leichmannii*. We have found that the estimate of vitamin B_{12} activity in sheep fæces obtained with *E. coli* as the test organism was always higher than that with *L. leichmannii*. The relation between the two measurements has been expressed as a ratio (Table 2).

TABLE 2. VITAMIN B_{12} EQUIVALENT PER GM. FÆCES AS VOIDED

During period *A*, the first three animals were in an advanced stage of the cobalt-deficiency syndrome and were refusing the greater part of their rations (ref. 1). The appetites of the other three had not begun to fall during period *A*, but during period *B* the untreated No. 9090 refused to consume the whole of the ration

Sheep No.	Period *A*			Period *B*			Treatment in period *B*
	Assay by *E. coli* (μgm.) (*C*)	Assay by *L. leichmannii* μgm. (*L*)	Ratio *C*/*L*	Assay by *E. coli* (μgm.) (*C*)	Assay by *L. leichmannii* (μgm.) (*L*)	Ratio *C*/*L*	
7009	—	—	—	0·66	0·46	1·4/1	Nil
5009	0·56	0·25	2·2/1	3·7	0·47	8/1	Cobalt (*per os*)
7019	0·77	0·46	1·7/1	0·75	0·28	2·7/1	Vitamin B_{12} (parenteral)
9090	—	—	—	0·45	0·30	1·5/1	Nil
5012	0·52	0·26	2·0/1	3·8	0·74	5/1	Cobalt (*per os*)
9072	0·50	0·21	2·4/1	0·46	0·25	1·8/1	Vitamin B_{12} (parenteral)

In the fæces of the cobalt-deficient sheep, the ratio was between 1·4 and 2·4 to 1. After the animals had been treated with cobalt (1 mgm. per day *per os*), each method of assay showed an increased concentration of 'vitamin B_{12}', and the ratio rose to 5 or higher. Injection of vitamin B_{12} (50 μgm. a day) into the animals had no appreciable effect on the vitamin B_{12}-like activity of a given weight of fæces.

It would seem that there are at least two "B_{12}-like factors" in sheep fæces and that their absolute and relative concentrations depend upon the level of available cobalt in the gut.

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LETTERS TO THE EDITORS

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Possibility of the Quaternary Fission of Uranium-235

In their classic paper[1] discussing the theory of the fission process, Bohr and Wheeler estimated the energy release to be expected in binary, ternary and quaternary fission of the compound nucleus of uranium-239. In the binary case, for fragments of equal mass, an energy release of 200 MeV. was obtained; for three nearly equal fragments, the energy release is slightly greater, being about 210 MeV., while for division into four comparable parts it falls to 150 MeV.

Experimental observation of the quaternary fission of uranium-235 was claimed by Ho, Tsien, Vigneron and Chastel in 1946 [2], when they observed an event in a photographic emulsion which they believed could be represented best as four-particle fission into masses of 81, 99, 36 and 20. In the analysis applied, there are an infinite number of solutions for the mass values but the chosen one gave a kinetic energy release of 114 MeV., which they regarded as fitting the theoretical estimate well. A second case, reported in 1947 [3], had three heavy fragments and one light fragment, and the estimated masses were given as 84, 76, 72 and 4, and the total kinetic energy release as 102 MeV. These two events occurred in the examination of 10,000 binary fission tracks, and the frequency of quaternary fission was derived as $0{\cdot}0002 \pm 0{\cdot}00015$ of that binary fission.

In a recent detailed study of the slow neutron fission of uranium-235 with special reference to rare modes of fission[4], more than 600,000 binary fission events have been examined. Some 1,000 ternary events with a long-range light fragment have been observed in this work, but only two events were recorded which could possibly be classed as quaternary fission. The two events concerned are small, having a maximum particle range of 14 μ. This makes measurement difficult, particularly with a heavily ionizing track suffering from multiple scattering, and analysis of the type employed by Tsien *et al.* does not yield satisfying results. It is not possible to determine whether the events are truly quaternary fission or whether they are explicable as due (1) to recoils projected by the pair of fission fragments in the act of separating, or (2) a ternary event with a random track superimposed. In any event, if quaternary fission is a physical possibility, these experiments suggest that the cross-section given by the French group is too high by at least a factor of ten.

Quaternary fission has also been looked for in the fast neutron fission of uranium and thorium[5], and the photo-fission of uranium[6] and thorium[7]. No evidence for fission into four fragments of equal mass has been found in these experiments, although in the photo-fission of uranium[8] and the fast neutron fission of thorium[9] an event consisting of the two heavy fission tracks and a pair of α-particles has been observed. In each case it was possible to show[8,9] that the disintegration could be explained as a ternary fission in which the third nucleus was the unstable beryllium-8 emitted in the ground-state and which immediately broke up into a pair of α-particles.

This body of evidence suggests that quaternary fission is a highly improbable process whatever the nucleus and mode of excitation.

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Viscosity and Thermal Conductivity of Liquid Argon

Some time ago[1], I put forward certain very simple suggestions concerning the mechanism of the viscosity of liquids. These notions led to, among other things, a formula for the viscosity of simple (monatomic) liquids at the melting point which has been surprisingly successful in representing the melting point viscosity, η_M, of liquid metals[2]. My assumption is that in a simple (monatomic) liquid at melting point the atoms are vibrating about a mean position which very slowly migrates, and that momentum is transferred from layer to layer of the liquid at the extreme librations. This gives for the viscosity at melting point:

$$\eta_M = A\frac{\nu m}{\sigma}, \qquad (1)$$

where ν is the frequency, m the mass of the atom and σ the interatomic distance, while A is a constant the precise calculation of which would be very difficult, but which must be about 1. I took it as 4/3 in my original paper.

Now if this simple theory has any physical meaning, the ratio of the thermal conductivity k to the coefficient of viscosity at the melting point should be given by considerations similar to those which apply in the case of gases. We are led to the formula:

$$\frac{k}{\eta} = Bc_v, \qquad (2)$$

where c_v is the specific heat in cal. per gm. at constant volume and B is again a constant which should be about 1. This formula should apply to monatomic liquids but, among them, not to metals, since with these the heat is transferred mainly by electrons, which transport very little of the momentum.

The recent determination of the thermal conductivity of liquid argon[3] enables us to test (2). The thermal conductivity extrapolates to $3{\cdot}08 \times 10^{-4}$ at the melting point, the viscosity[4] to $2{\cdot}82 \times 10^{-3}$, which gives $k/\eta = 0{\cdot}109$, while c_v at the melting point[5] is 0·138 cal./gm. The value of B therefore comes out to be 0·8, which is as near 1 as we can well expect with an approximate formula of this kind.

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Theories of Magnetic Storms and Auroræ

Recent theories of magnetic storms and auroræ due to Alfvén[1] and Martyn[2] have had considerable success in explaining various observations, though Alfvén and Chapman have both pointed out[3] that the most satisfactory test of these theories would be an experimental one. Further insight into these theories may also be expected using a different theoretical approach: instead of calculating typical orbits for the particles, the continuous gas model may be used. This facilitates the use of Maxwell's equations in considering the effect of the charged particles on the electromagnetic field; the knowledge gained about the field can then be used in discussing the orbits.

This approach leads to a criticism of that aspect of the theories mentioned which concerns the acceleration of the auroral particles; the acceleration of these particles gives rise to a 'back effect' which has not been taken into account by Alfvén or Martyn. In both theories the auroral particles are supposed to be accelerated by a steady electric field occurring within a few earth radii of the earth, although the mechanism by which this field is supposed to be set up is different in the two theories. If there were a region containing such an electric field, it is obvious that all charged particles in that region would be accelerated, and, if they were to acquire the necessary energy of 10 keV., all the electrons in this region would be moving in nearly the same direction with velocities of 6×10^9 cm./sec. Then if there are 100 electrons per c.c., as inferred from one theory, the current density is 300 e.s.u., which is relatively large, and Maxwell's equation:

$$c \operatorname{curl} \mathbf{H} - \partial \mathbf{E}/\partial t = 4\pi \mathbf{j},$$

must be considered. The displacement current becomes important only for phenomena at radio frequencies, so that |curl **H**| must be of the order of 10^{-7} gauss/cm., which again is relatively large. Just how curl **H** attains this magnitude must be discussed using another of Maxwell's equations:

$$\partial \mathbf{H}/\partial t = - c \operatorname{curl} \mathbf{E}.$$

I have investigated this question[4], using the approximation $\mathbf{E} = - \mathbf{u} \wedge \mathbf{H}/c$, where **u** is the bulk velocity of the gas; this approximation is valid before the current density becomes large and is therefore good enough to decide whether the current density becomes large. The point of the discussion is that the magnetic field reacts on the gas through the force density $\mathbf{j} \wedge \mathbf{H}/c$, and, since the temporal rate of change of the magnetic field depends on the velocity of the gas, the important question is whether this force density favours or opposes the type of motion which will increase |curl **H**| and therefore also increase the current density. It is found to oppose this type of motion except in the neighbourhood of a neutral point of the magnetic field, and hence, if |curl **H**| is to be increased elsewhere, some force is needed 'to drive the dynamo'. Alfvén and Martyn have not allowed for this reaction of the field on the gas, and it is therefore doubtful whether the accelerating processes they have proposed can occur.

The suggestion that an electric discharge would occur at a neutral point was first made by Giovanelli[5] in connexion with solar flares, and Hoyle[6] has proposed a theory of the aurora in which the auroral particles are accelerated at neutral points. The neutral points are due to the combination of the magnetic field of the earth and a magnetic field carried out from the sun. Alfvén's model does, in fact, incorporate a magnetic field of solar origin, and further discussion of all aspects of such models seems likely to be fruitful.

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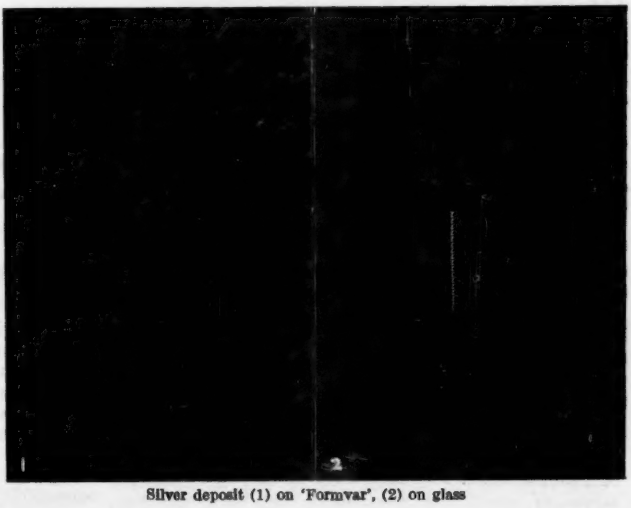
Thin Glass Layers as Supports for Electron Microscopy

In the usual technique of electron microscopy, 'Formvar' or collodion layers are used as supports. We have been studying the electrical properties of thin metallic layers and determined their structure by means of the electron microscope. The electrical resistances were made on glass strips, while 'Formvar' layers were used as support for the electron microscope examination. We have always hesitated to consider the picture obtained on 'Formvar' as identical with the structure obtained on the glass surface; therefore we tried to use very thin glass layers as supports, and eventually succeeded.

The technique is as follows. A closed glass tube is heated in a coal gas – oxygen flame and blown out suddenly into the air. Thus the room is filled with very small pieces of glass flakes floating down to the floor. The thickest ones come down first, while the



Silver deposit (1) on 'Formvar', (2) on glass

thinnest ones fall very slowly. The thin pieces of glass are caught on the surface of a vessel filled with water. Afterwards they are taken up from this water surface on the silver support for the electron microscope. The water is sufficient for the adhesion of the glass layer to the support. It is better, however, to fix the glass layer at one point by means of 'Formvar' used as adhesive material. In Figs. 1 and 2 are reproduced pictures, taken with a Philips electron microscope (*E.M.* 100), of the same silver layer obtained by sputtering on glass and the other on 'Formvar'. The magnification is about 20,000 for each.

It can be seen that the pictures obtained are similar in first approximation and are composed of small grains on a continuous underlayer. However, the grains on glass seem to be somewhat larger, as is also the separation between them. The macroscopic thickness, evaluated by weighing a test-plate, was found to be 950 A.

We are now trying to use much greater magnifications by making still thinner glass layers. At present the glass layers are made from Jena Geräte Glass 20.

We wish to thank the Centre Belge des Brasseries et des Malteries for financial help for this research.

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Dielectric Constant of Water Films

In order to explain some recent high-frequency (430 Mc./s.) measurements by Cownie and Palmer[1] on the variation in the dielectric constant of moist clay with water content, it was assumed[2] that the dielectric constant of the water increased exponentially from 3 (the high-frequency value for ice) at the water – clay boundary to 80 (the normal value for water) at an infinite distance from the boundary. It was supposed that the maximum change occurred in the thin layers of water close to the solid, and that the effects extended into the bulk of the liquid for appreciable distances.

That thin layers of water do exhibit abnormal mechanical and electrical properties is well known, and the terms 'bound' water[3] or 'l'eau "solide" '[4] have been used to indicate the ice-like properties of thin water films. The restricted movement of such 'bound' water molecules would presumably result in a value of the dielectric constant less than the normal value of 80.

In addition to the assumption that the dielectric constant of a water film varies with its thickness, it was found desirable to make a further assumption that the clay particles were both uniform in size and spherical in shape, although no steps had been taken to ensure this when the original experiments were undertaken. Consequently it has been decided to continue the investigation into the dielectric constant of thin water films by using certain composite or 'synthetic' dielectrics which are more amenable to theoretical treatment than is a clay – water mixture.

Preliminary experiments were made at frequencies of 2 and 3 Mc./s. with thin mica plates separated by layers of water. It was found that the dielectric constant of the water decreased with the thinness of the film from more than 20 for films about 5 μ in thickness to less than 10 for films about 2 μ in thickness (thickness calculated assuming no absorption). Even with very wet composite dielectrics, the dielectric constant of the water did not exceed 60.

It is known[5] that the dielectric constant of ice at a temperature not very much below 0° C. changes rapidly from about 90 to 3 when the frequency increases from just below to just above 10 kc./s. It was therefore thought that 'solid' water might exhibit a comparable variation about this frequency. To test this possibility, composite mica – water dielectrics were measured at 2 Mc./s. and at 2·5 kc./s. The value of the dielectric constant of the block of dielectric at the lower frequency was approximately double the value obtained at the higher frequency, indicating that the value of the dielectric constant of the inter-layer water was probably trebled or even quadrupled. In order to prevent evaporation between successive measurements, it was not possible (in these preliminary experiments) to make the necessary weighings which would enable the dielectric constant of the water alone to be calculated. A check experiment showed that the dielectric constant of the mica remained constant for this range of frequencies. Thus, since the dielectric constants of both water and mica are not frequency-sensitive over the range of frequencies used, whereas ice is frequency-sensitive at about 10 kc./s., it would appear that the water film is tending to act not as 'solid' water but rather as 'liquid' ice.

This is perhaps a subtle distinction; but it is an important one when problems relating to the dielectric properties of thin water films are under consideration. It is also conceivable that this point of view may contribute to a better understanding of the abnormal mechanical properties of thin liquid films.

Further experiments are in progress to confirm these conclusions, and it is proposed to extend the investigation to various forms of 'synthetic' dielectrics with liquids other than water as the matrix. We are indebted to our colleague Mr. J. Muir for assistance with the lower-frequency measurements.

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Relations between Small-Angle Interferences of Silk and the Wax Content

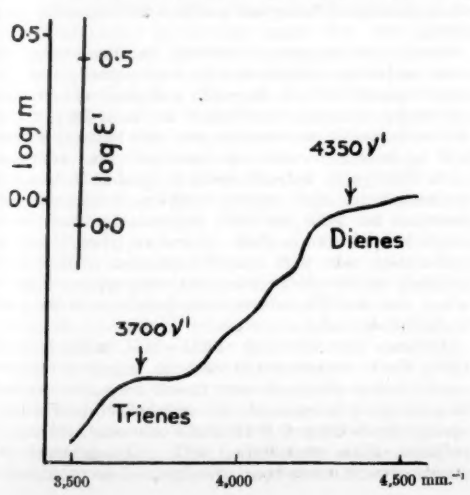
In previous papers[1] it has been established that alkali treatment of fresh preparations of silk fibroin gives rise to the appearance of new equatorial small-angle reflexions which were believed to be higher orders of a ground-period of 45 A. At first this effect was ascribed to a structural change of the silk lattice. Continued investigations, however, made it very likely that the new reflexions are due to some waxy substances. This assumption has now been confirmed

by means of the following experiments: (1) The new reflexions disappear if the sample is treated with 1:1 ether–alcohol for 8 hr. at 40° C. (2) After removing the solvent by evaporation, a waxy substance (1·6 per cent of the weight of the degummed silk) is obtained. This is in good accordance with the data of other authors, who have found 1–2 per cent wax in *Bombyx mori* silk[2]. The extracted substance shows sharp reflexions corresponding with the net-plane distances given in column 2 of the accompanying table. Column 1 gives the net-plane distances of alkali-treated fresh silk samples, and shows the good accordance between the inner reflexions of the extract and the strongest ones of the alkali-treated silk. The outer reflexions of the extract identify the substance as probably a wax. It is to be noticed, however, that the reflexion corresponding to the smallest angles is not so sharp. (3) Extracting the alkali-treated silk with ether–alcohol gives also a waxy residue (1·6 per cent of the degummed silk) showing practically the same diagram as is described under (2). (4) The ether–alcohol solution shows absorption bands in the ultra-violet at 3,700 and 4,400 mm.$^{-1}$ which are characteristic for conjugated unsaturated fatty acids. The extracted fat (or wax) contained 0·8 per cent conjugated dienes and 0·2 per cent trienes.

Net-plane distances (A.)	Reflexions (A.)
45	45
16	15
9·3	9·8
4·20	4·06
3·46	3·70
3·01	3·25
2·50	2·88
2·25	2·46
	2·22

This was to be expected, since Bergmann[4] has found liquid fatty acids in extracted silk wax, and linoleic and linolenic acid have been extracted from cocoons of *Bombyx mori*[5]. Bergmann, investigating the relations between fat content and mechanical properties, could not find any quantitative relations and concluded that the wax simply protects the fibre against wetting influences[6]. (5) Films of 'renatured' silk after alkali treatment do not show any new reflexions, as stated in previous papers[3].

The appearance of the new small-angle reflexions in the X-ray diagram of alkali-treated fresh samples of silk indicates that the hot alkali brings the primarily amorphous waxy substances to crystallization. Apparently the fresh samples with well-formed intermicellar spaces give better chances for such crystallization than older preparations with probably closer-packed units.



The net plane corresponding to the large wax period runs parallel with the well-developed plane of the micelles (grid-plane). Since this period coincides apparently with the longitudinal extension of the wax molecules, it seems probable that the chains of the fatty acids stand more or less perpendicular to the grid-plane of the micelle. This points to some interaction with the polar side-chains of the fibroin.

The fact that the silk fat (or wax) is primarily not crystallized points to a very subtle and perhaps monomolecular distribution.

Since it has been stated that unsaturated fatty acids promote distinctly the polymerization of proteins in general, and since Müller[7], for example, has shown that the fibrous denaturation of globular serum proteins is rendered possible by lipoidal substances, one is tempted to suggest also a functional significance for the silk fat in the transformation of the globular into the fibrous form.

We are indebted to Mrs. O. Gold for experimental assistance.

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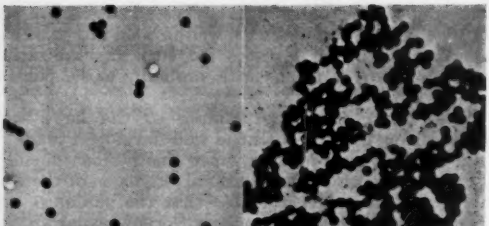
Resuspension of Dow Latex '580G' by Ultrasonics

Attempts to resuspend a sample of Dow polystyrene latex '580G'[1], which had dried out from 40 per cent suspension, by wet grinding and by shaking with water were only partially successful. Ultrasonic dispersion has been used and found to be successful under certain conditions.

Quantities of approximately 2·5 mgm. solidified latex in 10 ml. of soft tap water (hardness 20–30 p.p.m.), in a glass test-tube, diameter 2 cm., were placed in an oil-bath over the centre of a quartz crystal generating approximately 100 W. ultrasonic energy. Samples were treated for 30 sec., 90 sec., and 16 min., respectively, at 300 kc./s. with a continuous dissipation of approximately 10 W. in the sample. The suspensions produced were all found to be stable. Specimens prepared in an identical manner were examined in the electron microscope in an unshadowed condition, together with a sample of Dow latex '580G', which had not previously dried out, supplied by Dr. V. E. Cosslett.

The 30-sec. sample contained several undispersed fragments of the original solid together with single spheres and small planar groups. Very few fragments remained in the 90-sec. sample. The individual particles were still spherical and discrete (Fig. 1).



Ultrasonic treatment for (1) 90 sec., (2) 16 min.

The 16-min. sample, in addition to the usual single spheres and planar groups, contained many spheres which had been re-aggregated by the treatment and which had begun to coalesce, with a resultant loss of sphericity and diameter (Fig. 2). No such degenerate groups were found in the other samples.

As Jellinek and White[2] have shown that ultrasonic treatment of a polystyrene solution in benzene resulted in a progressive reduction of the average degree of polymerization, attention was paid to any possible changes in size and shape of the latex as a result of the treatment. Comparative measurements of the four samples were made at a fixed setting of the lens controls (magnification approximately 20,000) using several grids from each sample in order to minimize errors due to possible small magnification fluctuations between grids. No significant change was found in sphere diameter in either the 30- or 90-sec. treated samples, and it is concluded that a period of 90 sec. gives satisfactory resuspension. It is probable that the duration is not critical. It should be mentioned that in the samples from both sources a very small proportion of spheres appreciably larger or smaller than the average size exists; but these are quite readily recognized.

It is interesting to note that conditions for satisfactory resuspension of the latex are the same as those previously found by one of us (P. H.) for producing a stable carbon-black dispersion in water. The main requirements are: (*a*) low concentration of solid in liquid; (*b*) short period of ultrasonic treatment, usually less than 2 min. with the unit described above; (*c*) soft tap water. If these conditions are not satisfied, then a coarse dispersion is formed which settles out.

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Chemical Mechanism of Permanent Set

Some years ago[1] it was argued that the permanent set which strained wool fibres acquire in steam is due to two consecutive intramolecular reactions, namely, disulphide bond breakdown, which leads to the dissipation of stress, and linkage rebuilding, which stabilizes the relaxed structure. Indirect evidence of many kinds led to the conclusion that the reactions take place according to the following scheme:

$$R.CH_2.S.S.CH_2.R + H_2O \rightarrow R.CH_2SH + R.CH_2.SOH$$
$$R.CH_2.SOH + H_2N.R' \rightarrow R.CH_2.S.NH.R' + H_2O.$$

Following a suggestion of Phillips[3], evidence was afterwards obtained[3] that, when alkalis are used as setting assistants, —CH=N— as well as sulphenamide linkages are formed:

$$R.CH_2.SOH \rightarrow R.CHO + H_2S$$
$$R.CHO + H_2N.R' \rightarrow R.CH=N—R' + H_2O.$$

The above conception of the chemical mechanism of permanent set has, however, failed to command general acceptance, because Cuthbertson and Phillips[4] and Lindley and Phillips[5] found little or no fall in free amino-nitrogen, as estimated by the van Slyke reagent, after wool had been boiled for 1 hr. with borate buffers at *p*H 8 or *p*H 10, nor was there any rise in the content of cysteine. Direct evidence that the lysine side-chains of wool take part in the linkage-rebuilding reaction has now been obtained in the following way.

Several bundles of Lincoln wool fibres were stretched 40 per cent and set by immersion in a boiling 2 per cent solution of borax for 1 hr. After being washed in several changes of distilled water, the wool was treated with 1-fluoro-2:4-dinitrobenzene for 48 hr. at 37° C. under Sanger's conditions[6]. The fibres were washed thoroughly with alcohol and water before being hydrolysed for 24 hr. with 6 *N* hydrochloric acid, and the ε-N-dinitrophenyllysine was estimated after separation on a silica column in the usual way. Four sets of experiments were carried out, and the lysine content of the set fibres, after correction for decomposition during hydrolysis, was found to range from 2·15 to 2·53 per cent. Since the lysine content of the untreated wool, determined by the copper-complex technique[7], was 3·27 per cent, it is clear that the lysine content of wool is reduced when stretched fibres are set in a boiling solution of borax.

In another experiment, several bundles of set fibres were mixed and divided into two parts. One part was treated with 1-fluoro-2:4-dinitrobenzene, and the lysine content was found to be 2·02 per cent. When, however, the second part was hydrolysed with 6 *N* hydrochloric acid, without previous treatment with 1-fluoro-2:4-dinitrobenzene, the lysine content, estimated by the copper-complex technique, was found to be 3·33 per cent, the same as that of untreated wool. It is clear, therefore, that the lysine side-chains take part in the formation of new cross-linkages which are broken, with liberation of lysine, when the set fibres are hydrolysed in boiling 6 *N* hydrochloric acid.

Either —S—NH— or —CH=N— linkages would fulfil these requirements for, in experiments with model compounds, it was found that the sulphenamides are decomposed into sulphenic chlorides and amines by boiling 6 *N* hydrochloric acid. When the sulphenamides were boiled with hydrochloric acid in presence of mercaptans, disulphides were obtained.

Any rise in the cysteine content of set fibres would not, therefore, be detected in the hydrolysate if set is due mainly to the formation of sulphenamide cross-linkages.

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A Method for Overcoming 'Unsoundness' in Magnesian Limes

Building failures arising from the use of limes with a high content of magnesia have frequently been observed. These failures—such as spalling and blistering of plaster coats, disintegration of mortar joints and expansion of brickwork—are, according to Wells and others[1,2], caused by the slow hydration of the magnesia in these 'unsound' limes, and may extend over periods up to several years. Complete hydration of these limes can be obtained by treatment with high-pressure steam; this treatment, however, which is extensively used by American lime manufacturers, is expensive both in equipment and operation, and a simpler one is desirable. Experimental work in this Division has been based on the principle underlying Sorel cement manufacture, in which inert basic salts of magnesia such as magnesium oxychloride or magnesium oxysulphate are formed by the reaction between magnesium oxide and magnesium chloride or magnesium sulphate.

For the initial stages of the work in the laboratory, artificial mixtures of calcium oxide and magnesium oxide, prepared from the precipitated carbonates in proportions found in natural limestones, were used. The salts calcium chloride, magnesium chloride, magnesium sulphate and ammonium chloride were added to the samples, either in the hydrating water or after the hydration of the lime to powder or putty. In all instances the unsoundness as determined by a modified Le Chatelier autoclave expansion test (National Building Studies Special Report No. 3, 1948) was so reduced by calcium chloride, magnesium chloride and ammonium chloride that the material could be classed as sound. Magnesium sulphate was found to be much less effective than the other salts. The best results were obtained with calcium chloride added to the mixing water after hydration.

The salt treatment, when repeated with dolomite and magnesian limes made from natural materials, produced a similar decrease in expansion. On a pilot-plant scale the treatment proved equally satisfactory.

The effect of the salts on the general properties of mortars and plasters made from treated material has been investigated. The consistency, bulk density, workability and hygroscopicity were found to be practically unchanged, and the amount of water-soluble salts was well within the permissible limits. Plaster panels applied to a wall in the ordinary way are at present under observation.

The theoretical background of the reactions taking place in the process is being studied.

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Salting-out Chromatography of Amino-acids and Peptides in Filter Paper and other Media

Earlier investigations in this Institute[1] have shown that substances like dyestuffs and some proteins show a very marked increase of adsorption on to filter paper and other adsorbents in presence of salts in large concentrations. The adsorption may thus be increased from practically zero (in pure water) to considerable amounts, and the phenomenon may be utilized for chromatographic separations, using salt solutions of lower concentrations or even water for the elution. Similarly, Holman and Hagdahl[2] found that the adsorption of fatty acids on to carbon from solutions in ethanol was very markedly increased if the solubility was reduced by adding water to the solution.

In general, it is to be expected that the adsorption will increase as the solubility is reduced by changes in the medium which do not appreciably affect the adsorbing surface[3]. Recently, we have found that amino-acids and peptides show the same phenomenon both on charcoal and filter paper, and it is possible to obtain very satisfactory paper chromatograms based upon the salting-out principle by using, for example, strong phosphate buffer solutions as a medium. Figs. 1 and 2 show some paper chromatograms obtained in this way. (In absence of salts the adsorption is very small.) It is interesting to note that the order of the R_F values is to a certain extent reversed as compared with ordinary partition chromatography in butanol–water systems.

There seems to be a tendency for the salt to collect at the solvent front in the paper even if evaporation is prevented, and therefore the best results are obtained if the original spots are applied at a considerable distance behind the front. This enrichment of salts towards the advancing front points to a negative adsorption of the salts, that is, the water is more strongly bound by the cellulose than are the salts. This provides the necessary conditions for a salting-out effect, which may, of course, also be regarded as a kind of partition between a salt-rich and a salt-poor medium. There may also be some relations between this phenomenon and those described by Herbert and Pinsent[4] and Martin and Porter[5], where a second phase is created in ethanol–water or 'Cellosolve'–water systems by salting out, by which suitable conditions for chromatography of some proteins have been realized. The analogy to the effects of high salt concentrations in counter-current extraction according to Craig should also be noted[6].

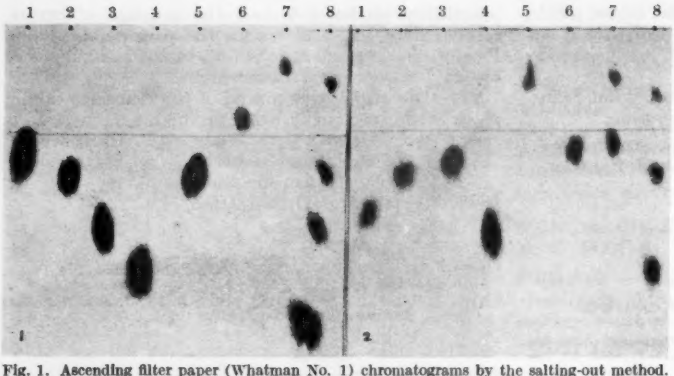

Fig. 1. Ascending filter paper (Whatman No. 1) chromatograms by the salting-out method. Salt medium: 1 *M* Na_2HPO_4 + 2 *M* NaH_2PO_4. The substances were applied as spots along the upper line after the paper had been soaked with salt solution to the lower line. (1) 0·005 ml. 0·25 per cent *dl*-leucine; (2) 0·0025 ml. 0·5 per cent *dl*-valine; (3) 0·0025 ml. 0·5 per cent *dl*-alanine; (4) 0·0025 ml. 0·5 per cent glycine; (5) 0·0025 ml. 0·5 per cent *dl*-methionine; (6) 0·0025 ml. 0·5 per cent *dl*-phenylalanine; (7) 0·005 ml. 0·25 per cent *dl*-tryptophane; (8) 0·01 ml. 0·125 per cent (*dl*-tryptophane + *dl*-phenylalanine + *dl*-leucine + glycine)

Fig. 2. Same as Fig. 1, but with the following substances: (1) 0·005 ml. 0·5 per cent *dl*-leucyl-glycyl-glycine; (2) 0·005 ml. 0·5 per cent *d*-leucyl-glycine; (3) 0·005 ml. 0·5 per cent glycyl-*l*-leucine; (4) 0·005 ml. 0·5 per cent glycyl-glycine; (5) 0·01 ml. 0·25 per cent glycyl-*l*-tryptophane; (6) 0·005 ml. 0·5 per cent glycyl-*l*-tyrosine; (7) 0·01 ml. 0·25 per cent (glycyl-*l*-tryptophane + glycyl-*l*-tyrosine); (8) 0·01 ml. 0·25 per cent (glycyl-*l*-tryptophane + glycyl-*l*-tyrosine + glycyl-glycine)

The principle appears to have wide applicability in chromatography, even if the large amounts of salt involved will sometimes present difficulties. On the other hand, the procedure can probably be used with advantage in many cases where lack of solubility in one phase makes it difficult to apply the partition method.

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Paper Chromatography of Phosphoric Esters

Bandurski and Axelrod[1] have recently published a paper describing modifications in Hanes and Isherwood's method[2] for the separation of phosphorylated sugars and adenosine phosphates by paper chromatography. Since these modifications are in certain respects similar to those being employed in this laboratory, this opportunity is being taken of indicating briefly the methods in use here.

Upward migration at 4° C. on acid-washed[2] paper is used in a similar manner to Bandurski and Axelrod, but the solvents used (Table 1) give higher R_F values and shorter running times than Hanes and Isherwood's mixtures, and tend to give smaller spots than Bandurski and Axelrod's mixtures. R_F values are difficult to reproduce accurately, but typical values are given in Table 2. For the detection of phosphate spots on the finished chromatogram, Hanes and Isherwood's reagent has been modified to allow the papers to be dipped instead of sprayed, by replacing part of the water with acetone[3]. *Molybdate reagent*: 1 gm. ammonium molybdate is dissolved in 8 ml. water and 3 ml. concentrated hydrochloric acid; 3 ml. perchloric acid (70 per cent) are added, and the mixture diluted to 100 ml. with A.R. acetone. Heating and treatment with hydrogen sulphide are as in the original method. Compounds absorbing ultra-violet light are detected by Markham and Smith's[4] photographic method, using a solution of chlorine in carbon tetrachloride instead of a chlorine gas filter. This modification allows a 1-cm. quartz cell to be used.

These methods are being applied to the quantitative separation of phosphorus-containing compounds in extracts from baker's yeast using bands instead of spots of concentrated extract applied to the starting line of the chromatogram with a very slow pipette[5]. By this method a commercial sample of adenosine triphosphate has been resolved into six constituents (adenosine triphosphate, adenosine diphosphate, adenylic acid, pyrophosphate, orthophosphate and a trace of an unknown ultra-violet-absorbing constituent), and analysed with good overall recoveries of total phosphorus and acid-labile phosphorus after cutting out the bands and eluting them with water by the capillary elution method of Dent[6]. The method is very suitable for the separation of traces of material from large amounts of interfering phosphates, and by its use glucose-1-phosphate equivalent to 6 μgm. of labile phosphorus was separated from about 300

Table 1. Solvent Mixtures

(1) 70 vol. methanol : 30 vol. 2 *N* ammonia.
(2) 75 vol. acetone : 25 vol. 25 per cent w/v trichloroacetic acid.
(3) 65 vol. acetone : 35 vol. 15 per cent w/v trichloroacetic acid.
(4) 60 vol. acetone : 40 vol. 35 per cent w/v monochloroacetic acid.
(5) 70 vol. acetone : 30 vol. 50 per cent w/v monochloroacetic acid.
(6) 60 vol. acetone : 40 vol. 35 per cent v/v formic acid.
(7) 50 vol. acetone : 50 vol. 30 per cent v/v acetic acid.

Table 2. Typical R_F Values

(No. 1 Whatman filter paper washed in 2 *N* hydrochloric acid and distilled water; solute applied as free acid or alkali salts)

Solute \ Solvent mixture	1	2	3	4	5	6	7
Orthophosphate	0·31	0·61	0·75	0·67	0·58	0·70	0·73
Pyrophosphate	0·12	0·40	0·51	0·38	0·29	0·40	0·46
Glucose-1-phosphate	0·42	0·22	0·48	0·31	0·15	0·30	0·41
Ribose-5-phosphate	0·36	—	—	0·46	—	—	0·41
Fructose-6-phosphate	0·37	0·31	—	0·37	0·15	0·40	—
Fructose-1,6-diphosphate	0·31	0·39	0·67	0·37	0·26	0·42	—
Adenosine-5-phosphate	0·29	0·37	0·58	0·30	0·10	0·24	0·31
Adenosine diphosphate	0·15	0·10	0·27	0·22	—	0·11	0·28
Adenosine triphosphate	0·11	0·04	0·15	0·05	0	0·04	0·13
Cocarboxylase	0·24	0·11	—	—	—	0·28	0·38
Guanylic acid	0·28	0·20	—	—	—	—	—
Cytidylic acid	0·37	0·34	—	—	—	—	0·36
Uridylic acid	0·40	0·51	—	—	—	—	0·51
Diphosphopyridine nucleotide	0·12	0	0·08	0·02	0	0·02	0·10

μgm. of orthophosphate phosphorus in a trichloroacetic acid extract of resting yeast.

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Stepwise Degradation of the Peptides liberated in the Transformation of Ovalbumin to Plakalbumin

In the transformation of ovalbumin to plakalbumin by a proteinase from *Bacillus subtilis*, a small amount of material containing non-protein nitrogen is released, which has been separated into three fractions, designated[1] *A*, *B*, and *C*. Amino-acid analysis of these fractions suggests that *A* and *B* are peptides composed chiefly of glycine, valine, aspartic acid and alanine, in the ratios 1 : 1 : 1 : 3 and 1 : 1 : 1 : 1, respectively, while *C* appears to be alanylalanine. As pointed out before[1], it is reasonable to suppose that the three peptide fractions arise all from the same segment of the ovalbumin molecule, represented by *A*. Accordingly, *B* and *C* should be identical with parts of *A*. The present investigation furnishes some evidence for this scheme.

In an attempt to establish the structure of the three ovalbumin peptides, each fraction was subjected to a stepwise degradation process. This was accomplished by successive removal of the N-terminal amino-acids according to a procedure based largely on Edman's[2] phenyl isothiocyanate method and applicable for use with small quantities of higher peptides. 5–30 micromoles of peptide were allowed to react with phenyl isothiocyanate in 2 ml. of a water–dioxane mixture (aqueous ethanol and acetone also proved satisfactory) at *p*H 8·0 and 40° C. The course of the reaction, in which one hydrogen ion is liberated per ammonium group, was followed and recorded by means of a Jacobsen–Léonis autotitrator[3], as illustrated by the curves in Fig. 1. After completion of the reaction, the content of the reaction vessel was transferred to a graduated tube, and excess reagent and dioxane were removed by continuous extraction with cyclohexane. The aqueous phase, containing the phenylcarbamyl peptide, was evaporated to a volume of 1 ml., acidified with 5 *N* hydrochloric acid to *p*H 1, and left standing at 75° C. for 1½–15 hr., depending on the ease of cleavage of the carbamyl peptide, to yield the 3-phenyl-2-thiohydantoin derivative of the N-terminal amino-acid and the residual peptide or amino-acid. The yield of thiohydantoin, which was removed completely from the graduated tube by continuous extraction with ether, was checked by measurement of its ultra-violet absorption as described by the Fraenkel-Conrats[4]. Hydrolysis of the thiohydantoin by barium hydroxide[2] yielded the terminal amino-acid, which was identified by filter-paper chromatography. The residual peptide or amino-acid solution was returned to the reaction

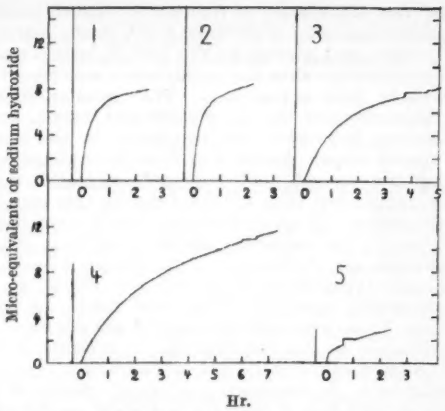

Fig. 1. Titration of terminal ammonium groups in the stepwise degradation of fraction *B*. Vertical lines in (4) and (5): titration from *p*H 5·8 to 8·0. Phenyl isothiocyanate added at zero time

vessel, brought to *p*H 5·8 with 1 *N* sodium hydroxide and then to *p*H 8·0 with a measured volume of 0·1 *N* sodium hydroxide. The entire procedure was then repeated.

By this method it could be confirmed that fraction *C* is alanylalanine, the first two degradation steps yielding equal quantities of alanine and the third step nothing. Similarly, fraction *B* could be identified as consisting, apart from an impurity containing glutamic acid (which may be a contamination from the bacterial enzyme preparation[5]), chiefly of alanylglycylvalylaspartic acid. This can be seen from the chromatogram reproduced in Fig. 2, in which the four component amino-acids appeared in the order indicated in the successive barium hydrolysates. The fifth run gave a blank, showing that one was dealing with a tetrapeptide. The titration curves in Fig. 1 indicate that during the entire degradation procedure there was little loss of peptide in the water phase, the amount of base consumed per ammonium group decreasing only slightly from one run to the next.

Fig. 2. Chromatogram of successively removed N-terminal amino-acids in fraction *B*. Whatman paper No. 1; phenol–water; descending chromatogram. Standards, from above to below: aspartic acid, glycine, alanine, valine. The spot in run 1 occupying a position between aspartic acid and glycine is due to glutamic acid

Stepwise degradation of fraction *A* yielded, beside unspecified amounts of glutamic acid[4], chiefly alanine as the first, and glycine as the second, amino-acid. In the third step valine and in the fourth step aspartic acid made their appearance. The chromatograms also showed spots due to glycine and valine, and particularly large spots due to alanine in the third and fourth steps. Analysis of the water phase following the second acid treatment revealsd that alanylalanine had been liberated during this part of the procedure. By more drastic acid treatment most of, if not all, the remaining alanine could be split off as alanylalanine. Incubation of the original *A* fraction with carboxypeptidase resulted in the liberation of approximately one-third of the total alanine as free alanine. These observations indicate the presence of alanylalanine at the carboxyl end of fraction *A*, in all likelihood linked to the rest of the fraction through aspartic acid. In summary, analysis of fraction *A* to date indicates that it contains as a chief constituent the hexapeptide, alanylglycylvalylaspartylalanylalanine. It may also contain other peptides which may be products of the 'unspecific' breakdown of ovalbumin.

A detailed account of these experiments will appear in the *Comptes Rendus des Travaux du Laboratoire Carlsberg* (Série Chimique). We wish to express our gratitude to Prof. K. Linderstrøm-Lang for encouragement and suggestions throughout the course of this work.

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Preparation of Crystals containing the Plakalbumin-forming Enzyme from *Bacillus subtilis*

OVALBUMIN is transformed by a proteolytic enzyme preparation from *Bacillus subtilis* into another protein, plakalbumin[1]. During the transformation a small amount of peptides is liberated[2]. An attempt has been made to purify the enzyme responsible for this transformation.

The bacteria were grown in submerged culture with vigorous aeration in a medium containing peptone, glucose and a salt solution containing trace metals. When after *c.* 30 hr. the enzyme concentration had reached a maximum, the bacteria were removed by centrifugation, the proteins in the culture liquid precipitated by addition of sodium sulphate, and the crude enzyme dried in a vacuum. A 10 per cent solution of the crude enzyme was purified by addition of calcium chloride in excess to precipitate the sulphate ions and of one volume of acetone to precipitate the mucins. The enzyme was precipitated by increasing the acetone concentration to 75 vol. per cent, and the precipitate dissolved in a small amount of water. After evaporation of the acetone,

Plakalbumin-forming enzyme, recrystallized. × 300

*p*H was adjusted to *c.* 5·5. The solution was made *c.* 5 per cent with respect to sodium sulphate, kept at *c.* 30° C. with mechanical stirring, and eventually seeded with crystals of the enzyme. When crystallization had started, the concentration of sodium sulphate was slowly raised to about 12 per cent. The enzyme crystallized out as long, very thin needles (see photograph). It was dissolved in water and recrystallized by addition of sodium sulphate. The activity of the enzyme was followed during the purification by measuring its ability to clot milk.

	Per cent of original nitrogen	Per cent of original activity	Activity per mgm. nitrogen	Activity per mgm. protein nitrogen
Solution of crude enzyme	(100)	(100)	5,550	
Precipitate 50–75 vol. per cent acetone	72	95	7,300	7,550
Dissolved crystals after :				
1. crystallization	64	84	7,300	7,450
2. ,,	59	76	7,100	7,300
3. ,,	55	71	7,130	7,350
4. ,,	49	64	7,200	7,450

During the purification, the plakalbumin-forming ability of the enzyme follows the milk-clotting activity within experimental error. The enzyme breaks down casein at almost the same rate as trypsin and about three times as fast as chymotrypsin. It has no amylase activity. Preliminary investigations in the electrophoresis apparatus show that about 95 per cent of the material moves as a symmetrical peak in an acetate buffer with sodium chloride, *p*H 5·3, ionic strength 0·1. In the ultracentrifuge, the material appears homogeneous with a sedimentation constant of *c.* 2·7 Svedberg units.

We wish to express our thanks to Prof. K. Linderstrøm-Lang for his interest in this investigation, and to Dr. H. C. Hagedorn who instigated the work.

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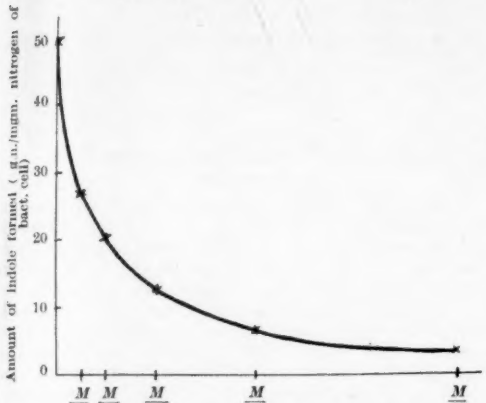
Competitive Action of Isonicotinic Acid Hydrazide and Vitamin B_6 in the Formation of Indole by *E. coli*

We have been seeking the mechanism to explain our observation that one of the substances which is contained in broth and is able to decrease the inhibitory effect of isonicotinic acid hydrazide on the growth of *E. coli* can, to some extent, be replaced by pyridoxine[1]. In further experiments, we have found that isonicotinic acid hydrazide considerably inhibits the formation by *E. coli* of indole, and that the activity of a suspension of *E. coli* treated with isonicotinic hydrazide recovers when the cells are in contact with pyridoxine.



Inhibitory activity of isonicotinic acid anhydride on the indole formation of *E. coli communior* (Exp. 1)

Typical results showing the inhibitory effect of isonicotinic acid hydrazide on the formation of indole by *E. coli communior* are given in the accompanying graph (Exp. 1), and the recovery effect due to pyridoxine is shown in Table 1 (Exp. 2). From the graph, it will be seen that the formation of indole by the washed suspension decreases considerably, generally in proportion to the amounts of isonicotinic acid hydrazide added; the rate of inhibition of isonicotinic acid hydrazide calculated from the results is given in Table 2.

The results in Tables 1 and 2 show that pyridoxine has a remarkable antagonistic action against the inhibitory effect on a cell suspension of isonicotinic acid hydrazide; for example, even 10^{-7} *M* (final concentration) of pyridoxine shows more than 50 per cent recovery effect.

In order to obtain the tryptophanase activity, the culture of *E. coli communior* (stock) was grown at

Table 1 (Exp. 2). Recovery Effect of Pyridoxine

Substrate: 0·4 ml. of *M*/160 DL-tryptophane in 3·4 ml. of reaction mixture. Reaction time: 10 minutes. Reaction temperature: 38° C.

Final concentration of INAH (*M*)	Final concentration of pyridoxine (*M*)	Indole formed (γ gm./mgm. nitrogen of bact. cell)	Recovery effect (per cent)
10^{-2}	10^{-4}	27·6	69·3
10^{-2}	10^{-5}	27·1	67·4
10^{-2}	10^{-6}	26·9	66·8
10^{-2}	10^{-7}	24·2	56·6
10^{-2}	10^{-8}	12·5	11·5
10^{-2}	10^{-9}	10·0	2·2
10^{-2}	—	9·5	0·0
—	—	35·7	—

Table 2

Final concentration of isonicotinic acid hydrazide (mol./lit.)	Inhibitory rate (per cent)
0·02	92
0·01	86
0·005	74
0·0025	58
0·00125	45
0·0	—

37° C. in broth containing 10 mgm./l. of DL-tryptophane for 18 hr. At the end of incubation, the organisms were centrifuged out of the growth medium, washed in saline three times and then made up into suspension in saline. The nitrogen content of the organisms per millimetre suspension was determined by the micro-Kjeldahl method as modified by Parnas.

As the preliminary experiments showed that contact for 30 min. was necessary for obtaining the complete action of isonicotinic acid hydrazide and of pyridoxine, suspensions of cells with the former or both of these substances respectively in phosphate buffer were incubated at 38° C. for 30 min. just before the determination of tryptophanase; the following quantities were used: in each test-tube, 0·5 ml. of washed suspension, 0·3 ml. of isonicotinic acid hydrazide solution, 1·9 ml. of *M*/15 phosphate buffer (*p*H 8·0), and in Experiment 2, 0·3 ml. of pyridoxine hydrochloride solution. The quantity of the liquid in each test-tube was made up to a volume of 3·0 ml. with distilled water.

In order to test the tryptophanase activity of these suspensions, the method of Wood *et al.*[2] with modifications was used throughout this work. The procedure is as follows: at the end of the contact, 0·4 ml. of *M*/160 DL-tryptophane was added to each test-tube and the reaction mixture was incubated at 38° C. for 10 min. The reaction was stopped by the addition of 0·2 ml. of 100 per cent trichloracetic acid; and 2–5 ml. of toluene containing the indole extracted from the reaction mixture by shaking was mixed thoroughly with 5·0 ml. of Ehrlich's reagent (2 gm. paradimethyl-amido benzaldehyde, 40 ml. concentrated hydrochloric acid, 190 ml. of ethanol). After 10 min. reaction, 5·0 ml. of ethanol was added to dissolve the toluene and the red-coloured solution was used immediately for electrophotometric determination.

Since it is generally agreed that the coenzyme of the tryptophanase of *E. coli* is identical with pyridoxal phosphate[2], it is thus apparent from our results that isonicotinic acid hydrazide may act on the tryptophanase as an antimetabolite against the coenzyme, and that the considerable recovery effect of pyridoxine is due to the competitive action of the pyridoxal phosphate, which may be produced in the cell from pyridoxine added. These results point in the same direction as our experiments on the inhibitory action of isonicotinic acid hydrazide on the decarboxylation of amino-acids by *E. coli*[3]. Further research is now in progress. This work will be published in detail later.

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Effect of D(+)-Leucine on the Hydrolysis of Glycil-L-Leucine in Normal and Neoplastic Tissues

In a previous paper[1], describing the beginning of a series of investigations on the action of D-amino-acids on L-peptidasic activity, it was observed that the effect of D(+)-leucine on hydrolysis of glycil-L-leucine by raw extracts of bovine intestinal mucosa clearly differed according to the *p*H of the reaction and to the final concentration of the D-amino-acid. D(+)-Leucine inhibited hydrolysis of glycil-L-leucine at a *p*H near the neutral point; it had no influence at an alkaline *p*H (8·5), while at an acid *p*H (6·2) it activated the reaction slightly.

Subsequent research showed that, when raw extracts of normal and pathological non-neoplastic human tissues were used in place of bovine mucosa extracts, the same results were obtained. The study of the effects produced by D(+)-leucine on the hydrolysis of glycil-L-leucine in human neoplastic tissues is therefore of considerable interest.

The material used in the present research consisted of twenty-five neoplasms (eight adenocarcinomas of the breast, three carcinomas (scirrhus) of the breast, one carcinoma of the gluteal zone, six carcinomas of the uterine cervix, two lymphosarcomas, two scapular sarcomas, two carcinomas of the rectum and one carcinoma of the penis). In all these cases it was definitely observed that D(+)-leucine affected hydrolysis of glycil-L-leucine in an entirely different way from that when normal and pathological but non-neoplastic human tissues were used; that is, from *p*H 6·2 to *p*H 8·5 it exerts a very marked activating influence. Such influence does not alter noticeably on varying the concentration of the D-amino-acid from 0·04 to 0·01 *M*; while at still lower molarity the activating effect decreases gradually, and ceases at a final concentration lower than 0·001 *M*. Control experiments with D(+)-leucine and extract alone were regularly made and no modifications at all were observed. When L(−)-leucine is used in place of its antipode, inhibitory action is, naturally, noted.

The method for the preparation of raw enzymatic extracts and for the tests of activity is described elsewhere[2], hydrolysis was determined by the measurement of liberated carboxyl groups[3], and in some experiments the liberated amino-groups were also determined (Van Slyke). For all tests, the temperature was 38° C., 0·1 *M* veronal buffer was employed and the *p*H controlled by means of a Cambridge *p*H meter, and the substrate solution was 0·025 *M* in the final reaction mixture.

Effect of D(+)-Leucine (L) on Hydrolysis of Glycil-L-Leucine (GL) by Human Non-neoplastic and Neoplastic Tissues

Conc. of D(+)-leucine	Time (min.)	*K* GL	*K* GL+L	Hydrolysis (per cent) GL	Hydrolysis (per cent) GL+L	Tissue
0·04 *M*	15	0·00305	0·00832	10	25	breast cancer
	30	0·00287	0·00780	18	42	
	60	0·00290	0·00824	33	68	
0·04 *M*	10	0·00315	0·00289	7	5	normal skin
	30	0·00305	0·00201	19	13	
	60	0·00319	0·00227	35	25	
0·01 *M*	10	0·00155	0·00706	3·5	15	uterine cancer
	30	0·00152	0·00602	10	34	
	60	0·00156	0·00562	19	54	
0·01 *M*	10	0·0173	0·0173	33	33	uterus, chronic metritis
	20	0·0173	0·0173	59	59	
	40	0·0159	0·0159	77	77	
0·01 *M*	5	0·0131	0·0309	14	39	adeno-carcinoma
	15	0·0147	0·0303	39	65	
	30	0·0136	0·0294	61	85	

Some of the results are shown in the table, where the values for hydrolysis are expressed as the first-order velocity constant calculated as a decimal logarithm (*K*); the *p*H is 7·2, since at this value D(+)-leucine (final concentration, 0·04 *M*) has a distinct inhibitory influence when non-neoplastic tissues are used.

Hence it is clear that the activating influence of D(+)-leucine on the hydrolysis of glycil-L-leucine (at *p*H 7·2) in the case of neoplastic tissues is just the opposite to the inhibitory one observed in normal and pathological non-neoplastic tissues.

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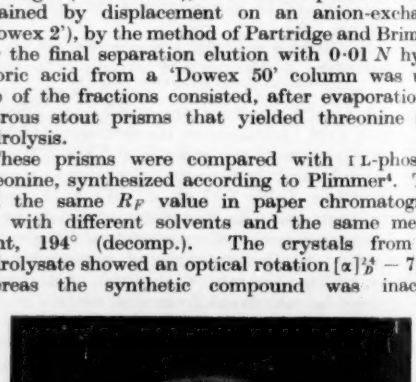
Isolation of Phosphothreonine from Bovine Casein

Lipmann has shown[1] that the phosphorus in casein is bound to serine, and this has been further confirmed by the isolation of crystalline phosphoserine in this Institute[2]; but it is also conceivable that a part of the phosphorus may be bound to threonine.

To investigate this, bovine casein was hydrolysed and a barium complex prepared, according to Lipmann. The barium was removed with a cation-exchanger ('Dowex 50'), and further purification was obtained by displacement on an anion-exchanger ('Dowex 2'), by the method of Partridge and Brimley[3]. For the final separation elution with 0·01 *N* hydrochloric acid from a 'Dowex 50' column was used. One of the fractions consisted, after evaporation, of lustrous stout prisms that yielded threonine after hydrolysis.

These prisms were compared with DL-phosphothreonine, synthesized according to Plimmer[4]. They had the same R_F value in paper chromatograms run with different solvents and the same melting point, 194° (decomp.). The crystals from the hydrolysate showed an optical rotation $[\alpha]_D^{14} - 7{\cdot}37°$, whereas the synthetic compound was inactive.



X-ray powder diffraction diagrams from (1) DL-phosphothreonine and (2) L-phosphothreonine

The X-ray powder diffraction patterns were identical. The molecular weight was 201·0 as calculated from X-ray diffraction data.

Analysis: $C_4H_{10}O_4NP$ (199·1)				
Calculated	C 24·1	H 5·06	N 7·04	P 15·6
DL-Phosphothreonine	24·0	5·13	6·89	13·4
L-Phosphothreonine	24·9	5·19	7·03	14·0

The phosphorus was determined by Teorell's method[5]. The low figures seem to be due to difficulties in hydrolysing.

These facts seem to indicate that the phosphoric acid in casein is bound not only to serine, but also to threonine.

A full account of this work, which was sponsored by the Swedish Medical Research Council, will appear elsewhere.

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Survival of Adrenal Gland Homografts in the Rabbit's Skin

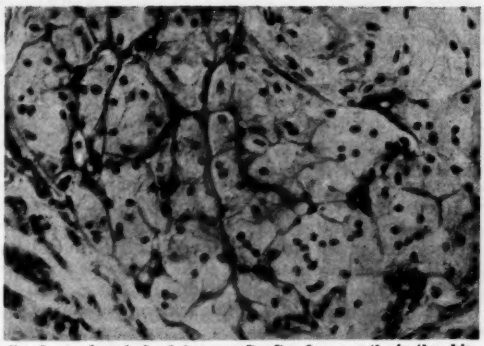
AN exception to the rule that tissue homografts in non-inbred mammals survive only for a few weeks has been observed in adrenal gland grafts transplanted from one adult rabbit to the skin of another. Such grafts live for many months, and appear to succumb finally to a type of disuse atrophy rather than to the usual homograft reaction.

Slices of adrenal gland including capsule, cortex and medulla, and weighing on the average about 25 mgm., were inserted into the fascial layer of the skin of the abdomen. At monthly intervals the grafts were exposed and measured and, beginning with the second month, tiny biopsy samples were taken. The grafts gradually diminish in size from the first month onwards.

Removal of one or both of the host's adrenal glands within five weeks of grafting was not followed by any noteworthy prolongation of the life of the graft or change in its histology. The chief determinant of the length of life of the graft appears to be the size of the original transplant; the results indicate that, in general, the bigger this is the longer will the graft survive. The biggest are still alive after seven months.

The medullary tissue did not survive, the grafts being composed of a capsule surrounding a mass of polyhedral cells which resembled enlarged zona fasciculata cells (see photograph). These cells gave positive reactions to tests for lipids, phospholipines, cholesterol and vitamin C, and there was a well-developed network of reticular fibres among them. They exhibited mitotic figures in a graft removed at two weeks, and in another removed at six weeks, after transplantation, but not in older grafts. Some of the signs of a homograft reaction, namely, infiltration of lymphocytes and plasma cells, and dilatation and congestion or destruction of the blood vessels, were observed in a few specimens, but they were usually weak or localized. The majority of grafts showed none of these signs.

The cells in most grafts undergo a slow process of degeneration. Their cytoplasm enlarges and frequently develops large fat droplets; the cell boundaries become indistinct and cells coalesce, so that multinucleate forms are common. Pyknotic and elongated nuclei are numerous in older grafts.



Cells of an adrenal gland homograft after five months in the skin of a bilaterally adrenalectomized rabbit

This degeneration of the homograft tissue is not surprising in normal or unilaterally adrenalectomized animals. But it also occurs in bilaterally adrenalectomized animals, and since these showed no distress after the disappearance of their grafts this suggests that accessory cortical tissue may take over the function of the glands. No cortical tissue was found on macroscopic examination of the sites of adrenalectomy at autopsy. The effect of later adrenalectomy and of implantation into the deeper parts of the body is now being tested.

The chief interest of the phenomenon lies in the apparent failure of the usual homograft reaction in these grafts and the indication that, contrary to the rule with other tissues, the larger the graft dosage the longer the survival. Submaxillary gland homografts transplanted to the same site and in the same dosage were found, when examined after two months, to be completely destroyed.

These findings are also of interest in relation to the reports of successful treatment of Addison's disease by means of adrenal gland homografts[1,2]. Lux, Higgins and Mann[3] reported survival up to twelve weeks of homografts of adrenal gland from new-born rabbits and guinea pigs when the grafts were first cultured in the presence of the host's serum and then transplanted into the groin. These grafts underwent a delayed, but ultimately strong, homograft reaction.

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Oxidation of Thiophosphate Insecticides in the Rat

THE problems encountered in assessing the toxicity of the organo-phosphorus insecticides towards mammals have been reviewed in a recent article by Aldridge and Barnes[1]. It was pointed out that compounds such as O-*p*-nitrophenyl O,O-diethyl thiophosphate (parathion, *E* 605) are considerably more potent *in vivo* as inhibitors of true cholinesterase than would be expected from their inhibitory activity *in vitro*; the summarized evidence indicated that thiophosphates

of this type are transformed into another more active inhibitor *in vivo*. It has been shown that the inhibitory action of technical parathion on true cholinesterase *in vitro* is due mainly, if not entirely, to an impurity of the form O-*p*-nitrophenyl O,S-diethyl thiophosphate[2]. Thus it was conceivable that the increased potency of parathion *in vivo* could be due to the formation of this S-ethyl isomer, but recent evidence seems to suggest that isomerization may not be the complete answer to this problem[3]. In the course of investigations on the selective inhibition of ali-esterase (tributyrinase), we have obtained evidence indicating that the thiophosphate insecticides may be oxidized *in vivo* to their phosphate analogues.

This conclusion is based upon a comparison of the relative inhibitory potencies of various analogous organo-phosphorus compounds towards the true cholinesterase and ali-esterase of rat brain *in vitro* and *in vivo*. Paraoxon (III) inhibits the true cholinesterase of rat brain more readily than the ali-esterase, both *in vitro* and *in vivo*, whereas the S-ethyl isomer of parathion (II) inhibits both enzymes to about the same extent *in vitro* and *in vivo*. A preparation of parathion (I) with a chemical purity of about 99 per cent also inhibited both enzymes equally well *in vitro*; but its inhibitory potency was only 1 per cent of that of the isomer (see table). These findings provide additional evidence in favour of the hypothesis that the inhibitory activity of parathion *in vitro* is due to the presence of a small amount of the S-ethyl isomer as impurity[2]. However, when this parathion preparation was injected into adult male rats, the true cholinesterase of the brain was found to be considerably more inhibited than the ali-esterase, as is also the case when paraoxon is injected. We surmise from these results that the inhibitory activity of parathion *in vivo* must be due largely to paraoxon, formed by enzymic oxidation of —P=S to —P=O.

There was some doubt as to whether this conclusion was completely justifiable because of the fact that the inhibitory action of parathion on the cholinesterase of rat brain is of fairly short duration[4], whereas that of paraoxon seems to recede less rapidly. However, the above hypothesis is strongly supported by the results obtained in experiments with the compound *bis*-(O-*p*-nitrophenyl) O-methyl thiophosphate (IV)[5], its S-methyl isomer (V) and the analogous phosphate (VI)[6].

True cholinesterase and ali-esterase activities of rat brain homogenate were determined manometrically with 0·03 *M* acetyl-β-methylcholine and 0·2 per cent tributyrin suspension as respective substrates[1]. The esterase inhibition *in vitro* was measured after incubation of the rat brain homogenate with the inhibitor in a 0·025 *M* bicarbonate buffer for 30 min. before the substrate was added. All inhibitor preparations had a chemical purity of 95–100 per cent[5] with the exception of the S-ethyl compound (II), which was 70 per cent pure; the concentrations of inhibitor are necessarily expressed in the table as molar concentration of crude preparation. The esterase inhibition *in vivo* was determined in the brains of adult male rats after intraperitoneal injection of the inhibitor solution; * indicates the appearance of muscular fibrillation and other symptoms of true cholinesterase inhibition[4,7]; † indicates one or two fatalities in a group of five rats before the time when the surviving rats were sacrificed. Compound V was obtained by isomerization of IV for 36 hr. at 140° C.; melting point after recrystallization, 106°–107° C.

In vitro, the phosphate ester is a selective inhibitor of true cholinesterase, while both the O-methyl thiophosphate and its S-methyl isomer are selective inhibitors of ali-esterase (see table). Whereas the O-methyl thiophosphate exhibits only 1 per cent of the inhibitory potency of the S-methyl isomer *in vitro*, it is significantly more active than this isomer against the true cholinesterase *in vivo*. Moreover, both the O-methyl thiophosphate and the phosphate ester are selective inhibitors of true cholinesterase *in vivo*, and only the S-methyl isomer inhibits the ali-esterase more strongly than the cholinesterase (see table).

Finally, it was observed that the initial esterase inhibition caused by the S-methyl isomer had almost completely disappeared 24 hr. after the injection of this compound into the rats; the inhibitory and toxic actions of the analogous phosphate, in contrast, continue to increase slowly between 4 and 24 hr. after injection. The effects of *bis*-(O-*p*-nitrophenyl) O-methyl thiophosphate *in vivo* are qualitatively identical with those of the phosphate analogue, and do not resemble those of the S-methyl isomer (see table).

Apparently the inhibitory activity of the O-methyl thiophosphate derivative *in vitro* is due to a contaminating trace of the S-methyl isomer; but its inhibitory action in the rat is probably due

Comparison of the Inhibitory Actions of Organo-phosphorus Derivatives on the Cholinesterase and Ali-esterase of Rat Brain *in vitro* and *in vivo*

Compound	Molar concentration producing 50 per cent inhibition *in vitro* of		Amount injected (mgm./100 gm.)	Per cent inhibition of esterases *in vivo*			
				1 hr. later			
	True cholinesterase	Ali-esterase		True cholinesterase	Ali-esterase		
(I) O-*p*-Nitrophenyl O,O-diethyl thiophosphate (parathion, *E* 605)	$2·5 \times 10^{-8}$	3×10^{-8}	0·6	86*	36		
(II) O-*p*-Nitrophenyl O,S-diethyl thiophosphate	$3·6 \times 10^{-7}$	4×10^{-7}	2·0	69	62		
(III) *p*-Nitrophenyl diethyl phosphate (paraoxon, *E* 600)	$0·1 \times 10^{-7}$	2×10^{-7}	0·15	78*	26		
				4 hr. later		24 hr. later	
				True cholinesterase	Ali-esterase	True cholinesterase	Ali-esterase
(IV) *Bis*-(O-*p*-Nitrophenyl) O-methyl thiophosphate	c. 10×10^{-4}	$0·6 \times 10^{-4}$	10	72	56	92*†	75
(V) *Bis*-(O-*p*-Nitrophenyl) S-methyl thiophosphate	12×10^{-6}	$0·8 \times 10^{-6}$	20	40	78	16	30
(VI) *Bis*-(*p*-Nitrophenyl) methyl phosphate	$0·3 \times 10^{-7}$	3×10^{-7}	2	86*	62	93*†	79

almost exclusively to the formation of the phosphate analogue. The quantitative difference, that is, the reduced toxicity of the O-methyl thiophosphate as compared with the phosphate analogue, could be explained by the various factors involved in the absorption and destruction of the injected thiophosphate before it is transformed into this phosphate. On the other hand, the S-methyl isomer does not appear to undergo any isomerization or oxidation *in vivo* and thus has essentially the same action *in vivo* as *in vitro*.

Should the effects described above be reproducible in other species, it would appear that the well-known differences in relative toxicity of analogous phosphates and thiophosphates towards various forms of life must be due mainly to differences in the water and lipid solubility of these compounds[5], and secondarily to differences in the ability of various animal species to oxidize and destroy the thiophosphates. The toxicity of the organo-phosphorus insecticides towards mammals seems to be dependent only on the inhibition of true cholinesterase[1,4,7]. Some of these compounds may also cause an appreciable inhibition of the ali-esterase in brain; however, no toxic symptoms are observed when the ali-esterase is inhibited selectively by *bis*-(O-*p*-nitrophenyl) S-methyl thiophosphate.

A detailed report of the investigations on ali-esterase inhibition will be published elsewhere.

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Response to Vitamin B_{12} of Grazing Cobalt-deficient Lambs*

Smith and collaborators[1,2] have shown that vitamin B_{12} injected in sufficient quantity will alleviate the symptoms of cobalt deficiency in penned lambs fed a special low-cobalt ration.

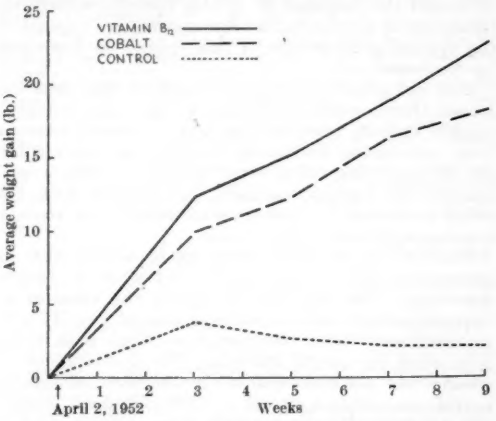
Since cobalt deficiency in grazing lambs is not uncommon in New Zealand, it seemed desirable to test the curative action of vitamin B_{12} on unthrifty lambs grazing a pasture of low cobalt content. For this purpose suitable experimental conditions were available at the Winton Experimental Farm, Southland. Previous work[3] had shown that liver and pasture samples were low in cobalt content and unthrifty lambs had responded significantly to cobalt dosing.

In the present trial, Romney–Southdown cross-bred lambs approximately 6½ months old were used. They had been confined to the same paddock since birth, and prior to the start of the experiment virtually all were showing signs of cobalt deficiency, as judged by small and erratic gains or actual losses in weight. Lambs were divided into three treatment groups as follows: (1) vitamin B_{12}-injected (4 lambs): 100 μgm. intramuscularly a lamb a week; (2) cobalt-dosed (19 lambs): 4 mgm. a lamb a week; (3) control (9 lambs).

* See also p. 791.

Treatments commenced on April 2, 1952. All lambs were weighed at the start of the experiment, again three weeks later, and thereafter at fortnightly intervals until June 4. At the end of the nine-week experimental period, vitamin B_{12}-treated lambs had each received a total of 800 μgm. vitamin B_{12} and cobalt-dosed lambs each 32 mgm. cobalt.

Average gains in weight are set out in the accompanying graph. Responses to both vitamin B_{12} and cobalt are highly significant ($P < 0.01$). Our figures suggest a more rapid response to vitamin B_{12} than to cobalt, but differences between the two groups do not attain significance.



These results show that, under the conditions of our experiment, grazing cobalt-deficient lambs respond at least equally as well to vitamin B_{12} as to cobalt. Australian workers[4] report a similar finding with adult merino ewes on low-cobalt pastures.

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[4] Marston, H. R., *Physiol. Rev.*, **32**, 66 (1952).

Induction of a Spawning Reflex in Hypophysectomized Killifish

The observations reported below were made during the course of a preliminary series of experiments with purified fractions of pollack pituitary glands, a study which I am undertaking in collaboration with Dr. A. E. Wilhelmi, Department of Biochemistry, Emory University, with the support of a grant from the U.S. National Science Foundation.

The test fish were two-year-old male *Fundulus heteroclitus* (L.), hypophysectomized at least two months prior to the experiment to allow time for the testes to undergo complete regression. Intraperitoneal injections of 1 per cent saline suspensions were made at a standard dosage level of 100 μgm./gm. weight. Controls, which exhibited no response, received an

equivalent volume of saline. Details of the effective fractions are reserved for later publication.

All fractions so far tested contain the melanophore-contracting hormone and pallor begins to develop 5–10 min. after injection. Shortly thereafter with certain fractions, on the average in 17 min., the fish become excited and begin to exhibit violent *S*-shaped spasms. Each spasm lasts from a few seconds to a minute or more. The fins are in rapid vibration or, more rarely, the fish becomes temporarily 'frozen' in a state of extreme flexure. A peak of activity is reached in about 30 min., after which there is a slow decline; but in the most potent fractions occasional spasms may be observed for as long as 1½–2 hr. The direction of flexure is either to the right or left with approximately equal frequency. The fish show no interest in each other but behave independently. Although the response is, in this respect, abnormal, there can be no doubt that the spasms are typical of the spawning behaviour of this species as described by Newman[1].

One completely hypophysectomized fish was injected thrice weekly for four weeks. At autopsy, nuptial colours were lacking and the testes were in total regression. Evidently the hormone responsible for the spawning reflex is not associated with stimulation of the regressed gonads. Nor can the spawning reflex be elicited by injections of methyl testosterone into hypophysectomized males.

Further experiments were made with pairs of unoperated fish, mostly well in advance of normal spawning. The response is exactly the same as in hypophysectomized fish and was elicited equally well in either sex. With the exception of one pair which were close to normal spawning, the development of spasms was not accompanied by emission of eggs or sperm, even after a second or third injection. Young fish, taken in their first spring, were as responsive as those with previous spawning experience.

In an attempt to identify the fraction responsible for the reflex, both normal and hypophysectomized fish were injected with a highly purified prolactin preparation. No response was elicited. Normal fish of both sexes were also injected with purified mammalian follicle-stimulating and luteinizing hormone (Armour and Co.). The follicle-stimulating hormone was inactive; but five out of six fish receiving the luteinizing hormone responded with characteristic spasms. The response appeared more slowly than with fish pituitary preparations, in 42–63 min., and it was less frequent. The luteinizing hormone was tested on a completely hypophysectomized fish and the response developed belatedly, in 77 min.

It is well known that injections of fish pituitary induce spawning in fish well in advance of the breeding season. Gerbilsky[2], an advocate of the neurocrine theory of the spawning hormone, has used intracranial injections for more rapid and effective results; in *Acipenser* the injected fish behaved in a tempestuous manner, leaping out of the water and often injuring themselves. Noble and his associates[3] induced brooding behaviour in the jewel fish, *Hemichromis*, with various pituitary preparations and also with injections of phenol; previous spawning experience was shown to be necessary, but the response could then be elicited even after castration, and it was further demonstrated that the nervous centres associated with the response were located in the corpus striatum. The findings reported in the present communication appear to confirm the theory that the spawning hormone of fish may stimulate sexual behaviour by a direct action on the nervous system. Furthermore, this hormone is apparently related to mammalian luteinizing hormone, which induces a similar response.

Grace E. Pickford
Bingham Oceanographic Laboratory,
Yale University.

[1] Newman, H. H., *Biol. Bull.*, **12**, 314 (1907).
[2] Gerbilsky, N. L., *C.R. (Doklady) Acad. Sci. USSR.*, **19**, 333 (1938).
[3] Noble, G. K., *Anat. Rec.* (Supp.), **64**, 88 (1936). Noble, G. K., and Kumpf, K. F., *Anat. Rec.* (Supp. 1), **67**, 113 (1936). Noble, G. K., Kumpf, K. F., and Billings, V. N., *Endocrinol.*, **23**, 353 (1938)

The 'Double Bang' of Supersonic Aircraft

Two explosive sounds in succession have sometimes been heard when aircraft in the vicinity exceeded the speed of sound. As I am not aware of any discussion of this phenomenon, I wish to direct attention to its explanation.

The condition for a shock to reach the stationary observer (in stationary air) can be stated simply with the aid of Huygens's wavelets: it occurs when the wavelets emanating from successive elements of the path of the source (the aircraft) superpose at the observer. This will happen when $-dr/dt = c$, where r is the (scalar) distance between aircraft and observer, and c is the speed of sound. Whatever the speed of the aircraft, no bang is heard by an observer with respect to whom $-dr/dt$ never exceeds the speed of sound. If it does exceed it, then there must be the point on the track where $-dr/dt$ first became equal to c; and, as a high speed of approach cannot be maintained indefinitely (at most until $r = 0$), there must be another point where $-dr/dt$ becomes again equal to c. Each of these two points is the origin of a bang for the particular observer, who would measure the direction and time accordingly.

The bang which is heard first is the one which was generated second, and it is expected to be usually the louder, having the closer origin. The second one to be heard may have its origin far away and hence be faint; but only if the aircraft has been flying nearly directly towards the observer for a long distance, or has been exceeding the speed of sound by a large margin. The most likely case at present appears to be a pair of similar bangs in quick succession.

The part of space in which the bangs can be heard is defined by a surface opening out in the forward direction from the point on the track where the aircraft first reached the speed of sound. An observer on this very surface would hear the two bangs merged into one.

The engine noise arrives at the observer in a complicated way: *before* the first and *after* the second bang, the noise is heard singly and in the time sequence of its generation; between the two bangs, there are three components of noise, one of which is reversed in time.

Note added on October 16. My attention has now been directed to a popular article in *Flight* of October 3 on this subject. That article contains no mention of the essential significance of the 'velocity of approach towards the observer' as distinct from the airspeed, and hence does not contain the main argument presented here.

T. Gold
Trinity College,
Cambridge. Oct. 5.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, November 10

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 5 p.m.—Prof. C. A. Cotton: "Tectonic Relief".

UNIVERSITY OF LONDON (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Dr. Henry E. Sigerist: "Landmarks in the History of Hygiene" (Heath Clark Lectures).* (Further Lectures on November 11, 12, 13 and 14.)

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE, PHILOSOPHY OF SCIENCE GROUP (in the Joint Staff Common Room, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Dr. J. O. Wisdom: "A Theory of Psychosomatic Disorder".

INSTITUTION OF ELECTRICAL ENGINEERS, EDUCATION DISCUSSION CIRCLE (at Savoy Place, Victoria Embankment, London, W.C.2), at 6 p.m.—Discussion on "The Teaching of Illumination Engineering".

PHARMACEUTICAL SOCIETY (at 17 Bloomsbury Square, London, W.C.1), at 7.30 p.m.—Dr. K. R. Capper: "The Extra Pharmacopoeia".

CHEMICAL SOCIETY, OXFORD SECTION (in the Physical Chemistry Laboratory, South Parks Road, Oxford), at 8.15 p.m.—Prof. G. E. Blackman: "Herbicides and Insecticides" (Alembic Club Lecture.) (All Fellows are invited.)

Tuesday, November 11

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Prof. G. E. Blackman: "Factors Affecting the Selective Toxicity of Herbicides". (Further Lecture on November 18.)

UNIVERSITY OF LONDON (at King's College, Strand, London, W.C.2), at 5.30 p.m.—Prof. C. A. Cotton: "Coastal Morphology and Classification".* (Further Lecture on November 13.)

ILLUMINATING ENGINEERING SOCIETY (at the Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 6 p.m.—Papers on "Factory Lighting".

Wednesday, November 12

ROYAL SANITARY INSTITUTE (at 90 Buckingham Palace Road, London, S.W.1), at 2.30 p.m.—Mr. H. E. Bywater: "The Hygienic and Economic Utilization of Offal and By-Products of Food Animals" (Benjamin Ward Richardson Lecture).

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Dr. E. G. Richardson: "The Science of Musical Instruments".

INSTITUTE OF PETROLEUM (at Manson House, 26 Portland Place, London, W.1), at 5.30 p.m.—Dr. S. F. Birch: "Sulphur Compounds in Petroleum".*

ROYAL AERONAUTICAL SOCIETY (at Vickers-Armstrong, Ltd., Weybridge), at 6 p.m.—Sir A. H. Roy Fedden: "Rex Pierson—an Appreciation and the Lessons of his Work" (First R. K. Pierson Memorial Lecture).

ROYAL STATISTICAL SOCIETY, STUDY SECTION (at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 6 p.m.—Discussion on "The Census 1951—1% Results" (Speakers: Mr. Harry Henry, Mr. E. Grebenik, Dr. J. Baxter).

SOCIETY OF COSMETIC CHEMISTS OF GREAT BRITAIN (at the British Colour Council, 13 Portman Square, London, W.1)—Dr. Stoves: "Hair".

Thursday, November 13

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Mr. B. C. Brookes: "Words and their Definitions".*

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Mr. R. H. Corkan and Dr. A. T. Doodson, F.R.S.: "Free Tidal Oscillations in a Rotating Square Sea"; Mr. J. Darbyshire: "The Generation of Waves by Wind".

ROYAL INSTITUTE OF CHEMISTRY, LONDON AND SOUTH-EASTERN COUNTIES SECTION (joint meeting with the UNIVERSITY CHEMICAL SOCIETY, in the Zoology Lecture Theatre, The University, Reading), at 8.15 p.m.—Dr. J. G. A. Griffiths: "Rockets and Chemistry".

Friday, November 14

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Prof. N. F. Mott, F.R.S.: "The Mechanism of Work-hardening in Metals" (Thomas Hawksley Lecture).

INSTITUTE OF PHYSICS, INDUSTRIAL SPECTROSCOPY GROUP (at 47 Belgrave Square, London, S.W.1), at 5.30 p.m.—Annual General Meeting; at 5.45 p.m.—Papers on "Vacuum Ultraviolet Spectroscopy".

SOCIETY OF CHEMICAL INDUSTRY, FINE CHEMICALS GROUP (in the Chemistry Lecture Theatre, King's College, Strand, London, W.C.2), at 7 p.m.—Dr. J. Carmichael: "Fine Chemicals in Veterinary Medicine".

Saturday, November 15

BIOCHEMICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 10.30 a.m.—Symposium on "Immunochemistry".

BRITISH PSYCHOLOGICAL SOCIETY (in the Eugenics Theatre, University College, Gower Street, London, W.C.1), at 2.30 p.m.—Prof. Sigmund Koch: "The Proper Functions of Theoretical Psychology".

ENGINEERS' STUDY GROUP (in Room 6, 20 Buckingham Street, London, W.C.2), at 3.15 p.m.—Annual General Meeting.

LONDON COUNTY COUNCIL (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Dr. Ludwig Koch: "Songs of Wild Birds and How I Recorded Them".*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

BIOCHEMIST (basic grade) (with a B.Sc. degree, preferably with honours in biochemistry or chemistry, or an equivalent qualification)—The House Governor, General Hospital, Birmingham 4 (November 15).

CHEMIST (Senior Scientific Assistant) in the Central Laboratory, Chiswick, with responsibility for section concerned with wide variety of analytical and investigational work other than metals, fuels, lubricants and paints—The Staff Officer (F/EV.221), London Transport, 55 Broadway, London, S.W.1 (November 15).

RESIDENT ASSISTANT LECTURER IN AGRICULTURE at the Cumberland and Westmorland Farm School, Newton Rigg, Penrith, and for lecturing, demonstration and advisory work in the two counties—The Director of Education, 5 Portland Square, Carlisle (November 15).

SECOND ASSISTANT ENGINEER (Chemist) (with first- or second-class honours degree in chemistry or associateship of the R.I.C., with emphasis on physical and inorganic chemistry) in the Generation Operation Branch at Bankside—The Director of Establishments, British Electricity Authority, British Electricity House, Winsley Street, London, W.1, quoting Ref. AE/297 (November 17).

SENIOR TOBACCO EXTENSION OFFICER (with a degree in agriculture, and wide experience in tobacco culture, particularly flue-cured Virginia, including curing, handling and marketing)—The Secretary, Southern Rhodesia Government, 429 Strand, London, W.C.2 (November 20).

ASSISTANT LECTURER IN GEOLOGY (with special qualifications in petrology and economic geology)—The Registrar, University College, Cathays Park, Cardiff (November 22).

DIRECTOR OF THE TASMANIAN MUSEUM AND ART GALLERY—The Agent-General for Tasmania, 457 Strand, London, W.C.2 (November 29).

ASSISTANT LECTURER (Grade III) IN PHYSIOLOGY (Veterinary)—The Registrar and Secretary, The University, Bristol (November 30).

LECTURER IN ECONOMICS at New England University College (University of Sydney), Armidale, N.S.W.—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (November 30).

SENIOR MASTERS (honours graduates) OF SCIENCE, MATHEMATICS, AND ARTS/LANGUAGES, at Welbeck Abbey, Worksop—The War Office (C.5), Whitehall, London, S.W.1 (November 30).

SENIOR RESEARCH OFFICER (with an honours degree in pure mathematics, with postgraduate or other training in mathematical statistics; research experience is essential) to be in charge of the Statistical Research Division, and a RESEARCH OFFICER (with an honours degree in psychology, preferably with mathematics and statistics as ancillary subjects) in the Industrial Research Team, to carry out research in the applied psychological field in industry, in the National Institute for Personnel Research, Johannesburg—The South African Scientific Liaison Officer, Africa House, Kingsway, London, W.C.2 (November 30).

LECTURER IN PHYSIOLOGY at University College, Dundee—The Secretary, The University, St. Andrews (December 1).

RESEARCH FELLOWSHIPS IN ECONOMIC HISTORY AND ECONOMIC STATISTICS, AUSTRALIAN HISTORY, LAW, STATISTICS, including MATHEMATICAL STATISTICS, GEOGRAPHY, INTERNATIONAL RELATIONS, AND PACIFIC HISTORY—The Administrative Officer in the U.K., Australian National University, 27 Russell Square, London, W.C.1 (December 1).

CHAIR OF MECHANICAL ENGINEERING and the CHAIR OF ELECTRICAL ENGINEERING, in the University of Roorkee, India—The High Commissioner of India (General Department), India House, Aldwych, London, W.C.2 (December 31).

ABSTRACTOR (a degree in engineering or physics is desirable) for duties consisting mainly of abstracting and summarizing technical and scientific papers in shipbuilding, marine engineering, naval architecture, general physics and engineering, and also dealing with technical inquiries relating to published material in these fields—The Secretary, British Shipbuilding Research Association, 5 Chesterfield Gardens, London, W.1.

ASSISTANT, Grade B (with a university degree in science) IN THE DEPARTMENT OF CHEMISTRY—The Principal, Borough Polytechnic, Borough Road, London, S.E.1.

ASSISTANT, Grade B (with honours degree in geology) IN GEOLOGY—The Principal, Derby Technical College, Normanton Road, Derby.

ASSISTANT STATISTICIAN to the Medical Research Council's Social Medicine Research Unit—Dr. J. N. Morris, Social Medicine Research Unit, Central Middlesex Hospital, Acton Lane, London, N.W.10.

CHIEF HYDROLOGICAL ENGINEER in the Soil Conservation Section of the Ministry of Agriculture—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Chief Hydrological Engineer 404'.

ENTOMOLOGIST to carry out a survey of the tsetse areas of the Sudan and undertake research work—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Entomologist 2204'.

GRADUATE IN CHEMISTRY OR PHYSICS as RESEARCH ASSISTANT IN CHEMICAL ENGINEERING DEPARTMENT, to do research on flame propagation in gases—The Registrar, Imperial College of Science and Technology, South Kensington, London, S.W.7.

GRADUATE IN PHARMACY (with industrial experience) in the Department of Pharmacy—The Secretary, Royal Technical College, Glasgow.

LECTURER IN PHYSICAL CHEMISTRY—The Principal, Sir John Cass College, Jewry Street, London, E.C.3.

PHYSICIST (senior or basic grade) IN THE RADIOTHERAPY DEPARTMENT—The Group Secretary, Central Office, Nunnery Fields Hospital, Canterbury.

PHYSICIST (with honours degree) FOR WORK IN TECHNOLOGICAL DEPARTMENT involving investigations into friction and measurement and control of yarn tension—The Secretary, British Rayon Research Association, Barton Dock Road, Urmston, Manchester.

PROFESSOR OF ANALYTICAL CHEMISTRY—The Chairman, Department of Chemistry, University of Montreal, Montreal 26, Canada.

RESEARCH ASSISTANT PHYSICIST to undertake the development of a recording microspectrophotometer and the investigation of dichroism of biological crystallites—The Secretary to the Board, Royal Infirmary Branch, Bristol 2.

SENIOR EXPERIMENTAL OFFICER at the Ministry of Supply Trials Wing Outstation, Aberporth, South Wales, for duties mainly concerned with control of operation and maintenance of electronic instruments and supervision of technical work—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting D.401/52A.

SURVEYORS (university graduates with a degree, preferably with honours, in mathematics, physics, engineering, or geography, including geodesy) in the Colonial Survey Service and the Directorate of Colonial Surveys—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

East Malling Research Station. Annual Report (thirty-ninth Year), 1951. Pp. 208+20 plates. (East Malling: East Malling Research Station, 1952.) 12*s*. 6*d*. [177

General Register Office. Census 1951, Great Britain, One Per Cent Sample Tables. Part 1: Ages and Marital Condition, Occupations, Industries, Housing of Private Households. Pp. xix+159. 17*s*. 6*d*. net. The Registrar General's Estimates of the Population of England and Wales; Populations of each Administrative Area at 30th June 1951. Pp. 16. 6*d*. net. (London: H.M. Stationery Office, 1952.) [217

Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences. No. 638, Vol. 236: Mortality among Voles (*Microtus agrestis*) at Lake Vyrnwy, Montgomeryshire, in 1936–9. By D. Chitty. Pp. 505–552+plates 36–37. 13*s*. 6*d*. No. 639, Vol. 236: Development and Biology of the Larva of *Saccoglossus horsti* (Enteropneusta). By C. Burdon-Jones. Pp. 553–590. 9*s*. (London: Cambridge University Press, 1952.) [217

Directory of Free Lance Journalists, Artists and Photographers. Pp. 58. (London: National Union of Journalists, 1952.) [217

Annual Report on the Progress of Rubber Technology. Vol. 15, 1951. Edited by Dr. T. J. Drakeley. (Published for the Institution of the Rubber Industry.) Pp. vii+135. (Cambridge: W. Heffer and Sons, Ltd., 1952.) 21*s*. [217

Bibliography of Industrial Drying. Vol. 1. Pp. vi+288. Vol. 2. Pp. vii–x+301–520. Vol. 3. Pp. xi–xvi+531–802+xvii–xxxv. (London: Department of Scientific and Industrial Research, 1951.) 27*s*. 6*d*. [217

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Committee of Privy Council for Medical Research. Report of the Medical Research Council for the Year 1950–1951. (Cmd. 8584.) Pp. iv+214. (London: H.M. Stationery Office, 1952.) 6*s*. net. [237

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Electrical Research Association. Technical Report L/T. 266: On the Vibrations of Long-chain Molecules, 1. By B. Szigeti. Pp. 12. 9*s*. Technical Report L/T.267: The Torsional Vibrations of Long-Chain Molecules, 2. By B. Szigeti. Pp. 10. 9*s*. (London: British Electrical and Allied Industries Research Association, 1951.) [237

University of Bristol. Annual Report of the Agricultural and Horticultural Research Station (the National Fruit and Cider Institute), Long Ashton, Bristol, 1951. Pp. 210+6 plates. (Bristol: The University, 1952.) [287

Hull Bulletins of Marine Ecology. Vol. 3, No. 23: Continuous Plankton Records—The Euphausiacea of the North-Eastern Atlantic and the North Sea, 1946–1948. By R. S. Glover. Pp. 185–214. (Hull: University College, 1952.) 5*s*. 6*d*. [287

International Wool Secretariat and the Wool Bureau, Inc. Annual Report, 1951–52. Pp. 50+46 plates. (London: International Wool Secretariat: New York: Wool Bureau, Inc., 1952.) [307

Freshwater Biological Association. Twentieth Annual Report, for the Year ending 31st March 1952. Pp. 53. (Ambleside: Freshwater Biological Association, 1952.) 2*s*. 6*d*. [307

Commonwealth Bureau of Soil Science. Technical Communication No. 47: Laterite and Lateritic Soils. By Prof. J. A. Prescott and Prof. R. L. Pendleton. Pp. iii+51+5 plates. (Farnham Royal: Commonwealth Agricultural Bureaux. 1952.) 6*s*. [307

Growth of Children: Sixty-six Boys and Girls each measured at Three Days, and at One, Two, Three, Four and Five Years of Age. By Prof. Alexander Low. Pp. v+64. (Aberdeen: The University, 1952.) 10*s*. [307

30th Report of Gresham's School Natural History Society, 1952. Pp. 16. (Holt: Gresham's School, 1952.) 1*s*. [307

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Scientific Institutions and Scientists in Latin-America. Ecuador, Vol. 1. Pp. iv+74. (Montevideo: Unesco Centro de Cooperacion Cientifica para América Latina, 1952.) [217

Canada: Department of Mines and Technical Surveys. Geological Survey of Canada, Memoir 263: The Stratigraphy and Trilobite Faunas of the Cambrian Sedimentary Rocks of Cape Breton Island, Nova Scotia. By R. D. Hutchinson. (No. 2502.) Pp. v+124. (Ottawa: Queen's Printer, 1952.) 75 cents. [217

State of California Department of Fish and Game: Bureau of Marine Fisheries. Fish Bulletin No. 85: The Biology of the Dover Sole, *Microstomus pacificus* (Lockington). By Frederick B. Hagerman. Pp. 48. (Terminal Island: California State Fisheries Laboratory, 1952.) [217

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Northern Rhodesia: Water Development and Irrigation Department. Annual Report for the Year 1951. Pp. 10. (Lusaka: Government Printer, 1952.) 1*s*. [217

Suomen Geodeettisen Laitoksen Julkaisuja. No. 41: Catalogue of Star Pairs for Northern Latitudes from 55° to 70° for Astronomic Determination of Latitudes by the Horrebow–Talcott Method. By Pentti Kalaja. Pp. 191. (Helsinki: Finnischen Geodätischen Institute, 1952.) [237

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Forest Department: Federation of Malaya. A Working Plan for the Matang Mangrove Forest Reserve, Perak. By D. S. P. Noakes. Pp. viii+173+17 plates. (Kuala Lumpur: Forest Department, 1952.) 8 dollars; 20*s*. [287

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Fieldiana. Geology, Vol. 10, No. 14: Fauna of the Upper Vale and Choza, 6, Diplocaulus. By Prof. Everett Claire Olson. Pp. 147–166. 35 cents. Zoology, Vol. 34, No. 4: The Surinam Coral Snake, *Micrurus surinamensis*. By Karl P. Schmidt. Pp. 25–34. 20 cents. (Chicago: Chicago Natural History Museum, 1952.) [307

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